

amateur radio

Vol. 38, No. 4

APRIL, 1970

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amateur radio

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Editor:

K. E. PINCOTT — VK3AFJ

Assistant Editor:

E. C. Manifold — VK6EM

Publications Committee:

Ken Gillespie — VK3GK
Peter Ramsay — VK3ZWN
W. E. J. Roper (Secretary) — VK3ARZ

Circulation—

Jack Kelly — VK3AFD

Draftsmen—

Clem Allan — VK3ZIV
John Blanch — VK3ZOL
John Whitehead — VK3YAC

Enquiries:

Mrs. BELLARS, Phone 41-3535, 478 Victoria Parade, East Melbourne, Vic., 3002. Hours: 10 a.m. to 3 p.m. only.

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CONTENTS

Technical Articles:—

	Page
Design Data for Short and Medium Length Yagi-Uda Arrays	13
S.W.R. Indicators—Trick or Treat?	12
The Wheatstone Bridge	7

W.I.A. Federal Executive:—

Federal Comment: "The Year in Review"	6
W.I.A. Federal Executive: Report to Federal Council (1970)	16

General:—

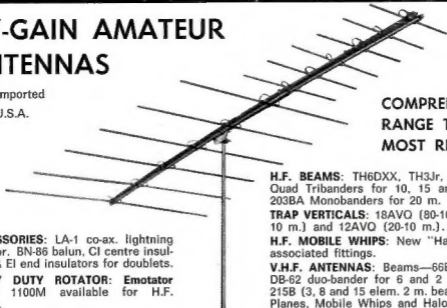
Contest Calendar	22
Correspondence	22
DX	19
Expedition to Cape Hicks	25
Federal Awards	25
Help Wanted	18
International Call Areas Award (I.C.A.A.)	24
New Call Signs	23
Obituary	22
Overseas Magazine Review	20
Prediction Charts for April 1970	20
Silent Keys	25
VHF	21
VK3 S.W.L. Group	25
WCPR-50 and WCPR Awards of I.A.R.C.	24
W.I.A. D.X.C.C.	25
W.I.A. V.H.F.C.C.	24
W.I.A. 52 MHz. W.A.S. Award	24

COVER STORY

Wolf Melchhardt (left) and Rick Sayers, VK4ZRS (right) of the Townsville Amateur Radio Club. Picture shows ingenious method of mounting 3 el. beam for 2 metre tx hunt on back of VK4EX's small sedan.

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THE WHEATSTONE BRIDGE

C. A. CULLINAN,* VK3AXU

LECTURE No. 4

The purpose of this lecture is to provide further practice with Ohms Law, and leads to the development of a practical Wheatstone Bridge suitable for measurement of Resistance, Capacitance and Inductance.

The Wheatstone Bridge is a device for accurate measurement of Resistance, Capacitance and Inductance.

The basic bridge was invented in 1833 by Samuel Hunter Christie, but no practical applications for its use were developed until 1843. In that year, Sir Charles Wheatstone applied Ohms Law to the bridge network in connection with problems in telegraphy.

As a result of this work the bridge has been known ever since as the Wheatstone Bridge.

Now-a-days there are many variations of the Wheatstone Bridge, these having been developed for specific purposes.



Fig. 1.

Consider the circuit of Fig. 1. Let each resistance be exactly 500 ohms and assume that the battery has no internal resistance. We know from d.c. theory that the total value of the two resistances will be 1,000 ohms.

We also know from our studies of Ohms Law that the voltage between A and B will be exactly the same as between B and C.

Let us prove this.

Firstly, we have to find the current (I) flowing in the two resistances.

From Ohms Law,

$$I = E \div R$$

$$\text{therefore } I = 100 \div 1,000$$

$$= 0.1 \text{ ampere or}$$

$$100 \text{ milliamperes.}$$

Next find the voltage between A and B.

Transposing Ohms Law formula,

$$E = I \times R$$

$$\text{therefore } E = 0.1 \times 500$$

$$= 50 \text{ volts.}$$

Now, since in our problem each of the two resistances is exactly equal to the other, then the voltage between B and C is also 50 volts.

The next step to develop the Wheatstone Bridge is to add two more resistances, each of exactly 500 ohms, wired in series and the combination connected in parallel across the battery (see Fig. 2).

Since R2 and R4 are exactly the same in value as R1 and R3, it follows that the current flowing in R2 and R4 is also 0.1 ampere.

Continuing the series of lectures by C. A. Cullinan, VK3AXU, at Broadcast Station 3CS for students studying for a P.M.G. Radio Operator's Certificate.

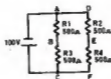


Fig. 2.

Therefore the voltage between D and E will be 50 volts, and between E and F, 50 volts.

We also know from d.c. theory that the current which flows in R1 and R3 flows in the same direction as the current in R2 and R4.

Therefore it becomes obvious that as the voltage at both B and E is 50 volts in respect to either the positive or negative pole of the battery, and as the polarity must be the same at both B and E, then there cannot be any difference of voltage, or potential difference, between B and E.

PRACTICAL EXPERIMENT

Connect a voltmeter of a type which does not consume current (such as a vacuum tube voltmeter) between points B and E. We will not be able to read any voltage.

Next let us remove the voltmeter and replace it with a sensitive ammeter.

This ammeter will have some resistance and we can now re-draw the circuit (Fig. 3) to show this ammeter.

In practice it would be a micro-ammeter having the pointer in the centre of the scale when no current is flowing. A current of 100 micro-amperes in either a positive or negative direction will cause the pointer to move full scale, either right or left. Such a meter is known as zero centre meter.

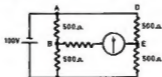


Fig. 3.

It will be found that no current will flow in the ammeter, because there is no potential difference between B and E.

What we have done so far is to prove that when R1, R2, R3 and R4 are exactly equal, no current will flow in the ammeter.

Suppose now that we change the value of the resistors. Let us make R1 and R2 each exactly 750 ohms and R3 and R4 250 ohms.

Using the formulae shown previously we find that the voltage between A and B, and also between D and E, will be 75 volts each, and between B and C, and also between E and F, will be 25 volts each. Once again no potential difference will exist between B and E, therefore no current can flow in the ammeter.

If we continue this type of analysis we find that if R1 and R2 are exactly equal and, if R3 and R4 are also equal, although R1, R2, R3 and R4 can be widely different (say 999 ohms each for R1 and R2, and 1 ohm for R3 and R4), then no current will flow in the ammeter. Calculate these figures and verify this statement.

But if we change the value of any one of the resistors, then current will flow in the ammeter because a potential difference will exist between B and E. Let us go back to our circuit and change the resistor values a little as shown in Fig. 4, for example. (Note erratum in the value of R4; this should read 100 ohms.)

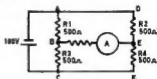


Fig. 4.

Note.—The value of R4 as shown is incorrect. R4 should read 100 ohms.

From our previous calculations we know that the voltage at B is 50 volts in respect to either A or C. However the voltage at E will be:

Between D and E, 83.33 volts, and between E and F, 16.66 volts. (Because of the recurring decimals, the total calculated voltage is not 100, but this does not matter in this calculation because it is sufficiently accurate.)

We now see that a potential or voltage difference exists between points B and E. Measure this with a vacuum tube voltmeter.

Now if we connect our ammeter between B and E it will show a current flow. Because of this current flow through the ammeter, our calculations above will not be exactly correct although they are for the vacuum tube voltmeter. Again we need not worry about this discrepancy.

We have now established the following regarding the Wheatstone Bridge:

1. If resistances R1 and R2 are equal to each other, no current flows in the ammeter if resistances R3 and R4 also are equal to each other. In other words, the Bridge is in a balanced condition.

2. If resistances R1 and R2 are equal to each other, current will flow

* 6 Adrian Street, Colac, Vic., 3260.

in the ammeter if resistances R3 and R4 are not equal to each other. The Bridge is **unbalanced**.

3. If resistances R1 and R2 are equal to each other and if either R3 or R4 is adjusted so that they become equal to each other, the Bridge becomes balanced and current will cease to flow through the ammeter.

4. If resistances R1 and R2 are equal to each other and either R3 or R4 is made an accurately calibrated variable resistance, then if we connect an unknown resistance for the remaining resistor we can measure the value of the unknown resistance by adjusting the calibrated resistance until no current flows in the ammeter, indicating that the bridge is balanced. We then read the scale or calibration of the calibrated resistor to give us the value of the unknown resistance.

Therefore Bridge Balance is obtained when $R1 + R3 = R2 + R4$.

Further mathematical analysis will show, too, that Bridge Balance can be obtained when $R1, R4 = R2, R3$.

A SIMPLE PRACTICAL BRIDGE

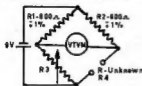


Fig. 5.

R3 is an adjustable, calibrated resistor, known as a decade resistance box. It can be adjusted in steps of 1 ohm from 0 to 1,111,110 ohms.

It consists of six switches. Each switch has one moving pole and eleven positions (Fig. 6). Position 1 is 0 ohms.

Switch 1 has 10 resistors each 1 ohm $\pm 1\%$, knob marked $\times 1$.
Switch 2 has 10 resistors each 10 ohms $\pm 1\%$, knob marked $\times 10$.
Switch 3 has 10 resistors each 100 ohms $\pm 1\%$, knob marked $\times 100$.
Switch 4 has 10 resistors each 1,000 ohms $\pm 1\%$, knob marked $\times 1K$.
Switch 5 has 10 resistors each 10K ohms $\pm 1\%$, knob marked $\times 10K$.
Switch 6 has 10 resistors each 100K ohms $\pm 1\%$, knob marked $\times 100K$.

The switches are wired in series.

The IN on the first switch and the OUT on the last switch are wired to terminals on the box so that it can be connected into various circuits.

The resistors are high stability types and the switches of good quality, preferably ceramic.

In a precision box artificially aged wire-wound resistances would be used. 100.0.

PRACTICAL WORK

The following items are available:—

- Two 600 ohms $\pm 1\%$ resistors.
- One decade resistance box as described above.
- One 9v. battery.
- One vacuum tube voltmeter. The meter can be set to half scale electrically to give a centre zero meter and use the 11 volts d.c. range for the bridge.
- One centre zero micro-ammeter, 100.0-100 μA .

Make up the above bridge using these components (Fig. 5). Use a number of different resistors as the unknown and balance the bridge with the decade resistance box. Note that sometimes an exact balance cannot be obtained because the exact value lies between two successive 1-ohm steps.

For normal practical radio work this bridge will measure resistors within its range with sufficient accuracy.

Balance occurs when $R1 + R3 = R2 + R4$, or

$$R1, R4 = R2, R3.$$

$$\text{Thus } R4 = (R2 \times R3) \div R1.$$

$$\text{Therefore } R4 = R3 (R2 \div R1).$$

This means that R4 must always be equal to the value of R3 times the multiplying factor ($R2 \div R1$).

If some fixed value is set for R1, then a change in R2 alone will change the multiplying factor.

Now this means that we can expand the usefulness of the original bridge to cover far greater values of R4, and this gives us a means of measuring a wide variety of resistance values if we allow R4 to represent each of these known resistances. Let us call R4, R unknown R_u or R_x . (The u or x signifying unknown.)

We can design, now, a more practical bridge than our earlier one.

Firstly, make R1 two precision resistors; 1,000 ohms and 10,000 ohms, with a switch so that either can be used, will be very suitable. The 1,000 ohm resistor used in one position only.

Secondly, R2 can be a number of switched precision resistors so that we can alter the ratio of R1 to R2. It is desirable that the resistors for R2 change in the ratio of 10-1 to make mental calculations easy. Thus R2 can be resistors one each of 1 ohm, 10 ohms, 100 ohms, 1,000 ohms, 10,000 ohms and two of 100,000 ohms.

The multiplying factors we get will be:—

$$\begin{aligned} R2 \div R1 &= 1 \div 10,000 \\ &= 10 \div 10,000 \\ &= 100 \div 10,000 \\ &= 1,000 \div 10,000 \\ &= 10,000 \div 10,000 \\ &= 100,000 \div 10,000 \\ &= 1,000,000 \div 10,000. \end{aligned}$$

and

In decimal equivalents these are: 0.0001, 0.001, 0.01, 0.1, 1.0, 10.0, and 100.0.

Thirdly, let R3 be a calibrated adjustable resistance of maximum value of 10,000 ohms. It can be a calibrated rheostat or a decade resistance box.

Referring back to our previous formula, $R_x = (R2 \times R3) \div R1 = R3 (R2 \div R1)$.

Now let us assume that R3 is set for 100 ohms and that R2 is switched to its 1 ohm resistor, then the bridge will balance only when R_x , the unknown, is 0.01 ohm, i.e. $R_x = 100 \text{ ohms}$. Ratio $(R2 \div R1) = 0.0001 = 100 \times 0.0001 = 0.01 \text{ ohm}$.

At the other end of the range of measurement of the instrument let the balance of the bridge be obtained with R3 at maximum resistance, 10,000 ohms, R1 switched to 1,000 ohms and R2 switched to 100,000 ohms. The ratio of $R2 \div R1 = 100$, so the value of the unknown resistance R_x is $R3 \times 100 = 10,000 \times 100 = 1 \text{ megohm}$.

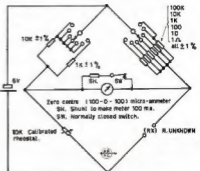


Fig. 7.

Note that only one 100,000 ohm resistor is used in R2 by paralleling the 8th and 7th contacts of the switch.

Depending on how small R3 can be set, in its minimum position, the range of measurement will be from 0.001 ohm (if R3 is 10 ohms) to 1 megohm, and the accuracy will depend on the degree of precision of all the resistors in use.

In many bridges R3 is a 10,000 ohms rheostat which has been calibrated so that 100 ohms is marked 0.1, 500 ohms 0.5, 1,000 ohms 1.0, 5,000 ohms 5, and 10,000 ohms 10, with appropriate markings in between.

(In practice, a bridge of this type can be made to measure to 0.001 ohm although theoretically it could go to 0.0001 ohm.)

The switch for the multiplying or ratio resistors R2 is marked with the multiplying factor. When balance is obtained it is only necessary to read the numerical calibration of R3 and multiply by the multiplier with simple mental arithmetic.

The next part of this lecture will deal with variations of the Wheatstone Bridge using a.c. as the power source and will conclude with a description of a versatile general-purpose bridge.

ALTERNATING CURRENT RESISTANCE MEASUREMENTS

The Wheatstone Bridges described so far use d.c. for the power source and a sensitive ammeter as the null or balance indicator.

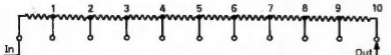


Fig. 6.

However, it is possible to use an alternating current as the power source and a pair of headphones to detect the null or balance when obtaining the d.c. resistance value of a resistance.

If an audio frequency oscillator, operating at 1,000 cycles per second, is connected in place of the battery as the power supply, then this tone will be heard in a pair of headphones, which are connected in place of the meter, except when the bridge is in perfect balance, and sometimes this is the preferred method to use.

However, it is essential that the a.c. resistance or reactance of the resistor being measured is very small, and not greater than the reactance of the various resistances used in the bridge. For instance, if the bridge is made from non-inductive resistors or resistors having negligible reactance at 1 KHz., then if a highly inductive resistor is used as the unknown, a proper balance would not be obtained.

However, it is possible to balance out the reactive component by connecting a condenser across one of the other arms of the bridge.

THE WHEATSTONE BRIDGE FOR MEASUREMENT OF CAPACITANCE

We have already seen that the Wheatstone Bridge can be used with a source of alternating current for the measurement of resistance, and since a capacitance will pass an alternating current, but will block a direct current, it would appear feasible to use an a.c. version of the Wheatstone Bridge to measure capacitance, and we will find that this is so although the bridge has to be arranged a little differently to the resistance bridge.

The reactance of a capacitance (condenser) is known as X_c and is derived from the formula X_c (in ohms) = $1 \div 2\pi FC$, where F is any frequency in Hertz (cycles) per second, C is the capacitance in farads.

Let us find the reactance of a condenser of $0.01 \mu F$, at 1,000 Hz. (cycles per second).

Then $X_c = 2 \times 3.14 \times 1000 \times 0.01 \times 10^{-6}$.

If the reactance of some condensers is calculated to three significant figures at the same frequency, it will be seen that the reactance of a condenser varies in inverse proportion to its capacity, i.e. at 1,000 Hz.:

0.001 μF = 159,100 ohms
0.01 μF = 15,910 "
0.1 μF = 1,591 "
1.0 μF = 159 "

Obviously from this we cannot substitute an unknown condenser in place of the unknown resistance (R_x) in our resistance bridge.

However, let us examine the situation with our simple bridge if we substitute a known value of capacitance for one of the ratio arms of the bridge (Fig. 8).

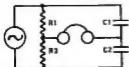


Fig. 8.

Referring to our earlier discussion of the development of the Wheatstone Bridge, we can apply the same reasoning to this new circuit.

If the resistance of $R1$ equals the reactance of $C1$, and if the resistance of $R3$ equals the reactance of $C2$, then the bridge will balance. (This statement is a simplification of the system.)

The formula for balance is:—

$$\frac{R1}{1} = \frac{R3}{C2}$$

$$\text{or } \frac{R3}{C1} = \frac{R1}{C2}$$

$$\text{This becomes } C1 = \frac{R3}{R1} (C2).$$

Therefore we make $C2$ a condenser of known value, of good quality and high accuracy and use it as a standard of reference.

The bridge now appears as shown in Fig. 9.

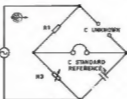


Fig. 9.

We can easily make this bridge more practical and incorporate in it some of the resistances used in our more elaborate d.c. resistance bridge.

Firstly, we change the previous bank of multiplier resistances over to the $R1$ position, leave $R3$ the calibrated variable resistance and use two switched standard condensers in place of the previous unknown resistance R_x . $C1$, the unknown condenser, takes the place of $R2$.

However, we still have a problem to solve.

Condensers have internal resistance and this can vary considerably. The losses in condensers cause the power factor of condensers to differ widely and unless the power factor of the unknown condenser is equal, exactly, to that of the standard reference condenser, then the bridge will not balance because the phase shifts will not be the same.

Now precision condensers are necessarily good condensers and they are expensive, but they will have very low losses hence the power factor will be low.

If a condenser could be manufactured without losses then its power factor would be zero and if resistance were added in series with it, then the combination would represent a condenser with losses.

Now if the standard reference condenser is a really good one, with negligible losses, then we could add a variable resistance in series with it to make its power factor the same as that of the unknown condenser (unless the unknown has an even better power factor, a rather unlikely situation if we make a good bridge).

An expression for the approximate power factor is:—

$$\text{Power factor} = \frac{R}{2\pi FC}$$

$$= R (2\pi FC)$$

where R is the value of the series resistance of the condenser, and $1 \div (2\pi FC)$ is the reactance of the condenser.

This is known as the Dissipation Factor, CD.

In order to cover a wide range of capacitance measurement, it is desirable to use two standard reference condensers, one of $0.01 \mu F$, and the other $0.1 \mu F$. Both should be high quality mica condensers, not paper dielectric types as the mica ones will have lower losses.

Each condenser should be accurate in its value to within $\pm 1\%$.

Let us see what happens if we calculate the power factor for the $0.01 \mu F$ condenser at 1,000 Hz, from the above formula.

$$\text{Power factor (Pf)} =$$

$$6.28 \times 1,000 \times 0.01 \times 10^{-6}$$

$$= 0.0000628$$

assuming the condenser has negligible losses.

If we wish to be able to compensate for unknown condensers having a power factor up to 1.0 we must put a variable resistor in series with our $0.01 \mu F$ condenser so that it will appear to have a power factor of 1.0.

If we calculate the maximum value of this resistor we will find that one of 16,000 ohms will give a power factor of 1.0048, i.e. $0.0000628 \times 16,000 = 1.0048$. Whilst 0 ohms will give a power factor of 0. Therefore various resistance values between 0 and 16,000 ohms will enable us to obtain power factor or dissipation factor adjustments between 0 and 1.

However in order to use the $0.1 \mu F$ standard condenser it would not be practicable to utilise the 16,000 ohms variable resistor but one of one-tenth this resistance would be suitable.

In practice, it may not be possible to obtain variable resistances of exactly 1,600 and 16,000 ohms, so that it would be necessary to use standard rheostats or potentiometers of 2,000 and 20,000 ohms respectively and ignore the resistance above either 1,600 ohms or 16,000 ohms.

Each of these two resistances can be calculated 0-10 and given simple multiplying factors to make the bridge more readily useable.

In bridge terminology the 16,000 ohms variable resistor is known as a $3Q$ resistor and the 1,600 ohms variable resistor is labelled CD . The switch used to change from one to the other is labelled CDQ .

The practical bridge now appears as shown in Fig. 10.

To operate the bridge, $S1$ is set to the approximate range for the condenser to be measured. $R2$ is then varied for minimum sound in the headphones. $S2$ is switched to CD and the CD resistance varied, together with $R3$. If a proper null cannot be found, $S2$ is switched to DQ and the DQ resistor

varied, together with R3. There may be some interlocking between R3 and either the CD or DQ resistors. Also, it may be necessary to alter the setting of switch S1. It may not be possible to get a complete null but the one obtained should be very deep. Stray capacity to ground in the 1,000 Hz. generator, and other stray capacities, may make a complete null impossible.

Some experience is desirable in learning to adjust this type of bridge so at the start the student should use well marked condensers for the unknown in order to obtain practice.

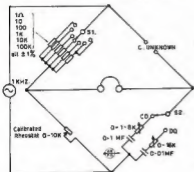


Fig. 10.

THE WHEATSTONE BRIDGE FOR MEASUREMENT OF INDUCTANCE

As the reactance of an inductor varies directly with the inductance, the Wheatstone Bridge can be used for the measurement of inductance in a similar manner as for resistance measurements, if a.c. is used instead of d.c., and an inductance standard is used in place of the resistance standard.

However, in practical bridges for inductance measurement it is not usual to use an inductance for the standard because an inductance may be influenced by external magnetic fields, also in most types of inductors variations in inductance occur as the applied voltage varies. Obviously such variations in inductance are undesirable in a standard.

Fortunately it is possible to use a capacitor in a bridge for the measurement of inductance if the position of the bridge arms are interchanged.

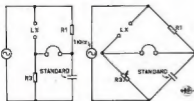


Fig. 11.

It will be noted that the standard reference capacitor and the unknown are in opposite arms (see Fig. 11), thus an increase in reactance in one arm is compensated by a decrease in the other opposite arm and the ratio of the two reactances is given by the ratio of the two resistance arms R1 and R3.

Just as it is impossible to make a capacitor which does not have any losses so it is impossible to make an inductance which does not have losses, therefore with such an inductance bridge as shown, it would be almost impossible to obtain a true null because of the differences in phase shift.

Fortunately adjustable resistances can be added to the arm having the standard so that losses can be added artificially to give the standard arm the same losses as appear in the "unknown" arm. Such resistances can be calibrated to give the energy factor or Q of the unknown inductor.

If such a resistance is connected in series with the standard condenser then the bridge is known as a Hay's Bridge and resistor can be calibrated to read values of Q in excess of 10.

For values of Q less than 10, a resistor is connected in parallel with the standard condenser and this circuit is known as a Maxwell's Bridge.

Two resistances will be required and fortunately one of the resistors used in the capacity bridge may be used for the Maxwell Bridge. The switch for these resistors may be marked LDQ and LQ.

In the LDQ position, the DQ resistor will have a useful range of 160 to 16,000 ohms, and dial controlling

this resistor being calibrated 0 to 10. 0 equals 0 ohms, and 10 equals 16,000 ohms.

Now if the switch is in the LQ position, then a new variable resistor of 0-165 ohms is connected in series with the standard condenser to make the Hay Bridge. The dial for this resistor is calibrated 0 to 10.

The various bridges so far discussed can be made into a single instrument which will measure resistance from 0.01 ohm to 1 megohm; capacitance from 10 pF. to 100 μF.; with two ranges of power factor 0-0.1 and 0-1; and inductance from 10 microhenries to 100 henries, with two ranges of Q, 0-10 and 0-1,000 respectively.

The audio frequency must be 1,000 Hz.

The bridge just described is basically similar to the very popular General Radio type 650A Impedance Bridge.

As mentioned earlier, stray capacitance in the audio frequency source and the detector may prevent complete nulls being obtained. In professionally made bridges, specially balanced and shielded transformers are used between the audio frequency source and the bridge, also between the bridge and the detector to remove the effects of such stray capacities.

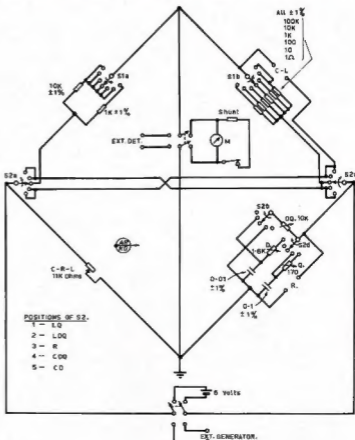


Fig. 12.

Wheatstone Bridges such as these described find considerable use in radio work and the student should become completely familiar with the theory and if possible practice of these bridges.

S1—2 pole, 7 position switch, 2 banks.

S2—4 pole, 5 position switch, 4 banks.

Switches preferably ceramic.

All fixed resistances, high stability, $\pm 1\%$.

C-R-L—0-10,000 or 0-11,000 ohms linear w.w. rheostat or potentiometer used as a rheostat. This should be the largest diameter it is possible to obtain. To be fitted with 6" dial as described in the text.

D—0-1,800 ohms linear w.w. rheostat.

Q—0-170 ohms linear w.w. rheostat.

DQ—0-16,000 ohms linear w.w. rheostat.

If these values are not available, rheostats with slightly larger maximum values can be shunted with suitable fixed resistors to obtain the desired values.

TABLE 1

The seven positions of switch S1 (Fig. 12) should be marked as follows. These markings become the multiplying factors to be applied to the particular calibration marking of the C-R-L dial when a null has been obtained.

Sw. S1 Pos'n.	C	R	L
1	10 μ F.	0.1 Ω	100 μ H.
2	1 μ F.	1 Ω	1 mH.
3	0.1 μ F.	10 Ω	10 mH.
4	0.01 μ F.	100 Ω	100 mH.
5	0.001 μ F.	1,000 Ω	1 H.
6	0.0001 μ F.	10,000 Ω	10 H.
7	—	100,000 Ω	—

Example.—Assume that when measuring some resistances that S1 is set to position 5 (marked 1,000 ohms) and that a null is found in the C-R-L dial at 7, then $7 \times 1,000 = 7,000$ ohms. If the null was found at 0.7 on the C-R-L dial, then the unknown resistance would be 700 ohms ($0.7 \times 1,000$).

Caution.—Due to the tolerances of $\pm 1\%$ used in the fixed resistances it

distance and capacitance and 15% for inductance.

Precision laboratory bridges will do much better than this and will be corresponding more expensive to manufacture.

TABLE 2

Calibration of the C-R-L dial for the C-R-L rheostat. The rheostat must be not less than 10,000 ohms at maximum resistance and should be not more than 11,000 ohms.

The overall accuracy of the bridge will depend on the accuracy with which the C-R-L rheostat can be calibrated. The dial should be at least 6" in diameter and can be made from a piece of 1/8" flat brass plate, turned to a 6" diameter disc in a lathe, and fitted with a large skirt knob.

There are three ways of making the calibration. The first is to use a high quality ohmmeter. The second is to use another bridge, and the third method is to connect the rheostat in series with a 6 volt battery and an 0-1 mA. meter with shunts to 1 ampere. Measurements of the current flowing in the rheostat are made for various settings of the rheostat and the resistance calculated from Ohms Law.

As it may be difficult to determine the internal resistance of the battery, this should be ignored.

Calibration of the C-R-L Dial

Dial	Resist. of Rheostat in Ohms	Dial	Resist. of Rheostat in Ohms
0	0	1	1,000
0.1	100	2	2,000
0.2	200	3	3,000
0.3	300	4	4,000
0.4	400	5	5,000
0.5	500	6	6,000
0.6	600	7	7,000
0.7	700	8	8,000
0.8	800	9	9,000
0.9	900	10	10,000
		11	11,000

Intermediate points can be determined from this table.

This switch is marked as follows:

$D = R \times C$		C		R	L	$Q = \frac{wL}{R}$	
Dial	Multiplier	D	DQ	0.1	DQ	Q	Multiplier
		0.01				1	100

The calibration for the D, Q and DQ rheostats can be determined in the formulae given earlier.

may be found that slightly different values may be obtained for the unknown resistor when adjacent switch positions are used, i.e. assume that the unknown is 1,000 ohms. With S1 on position 5, the C-R-L dial should read 1 ($1,000 \times 1 = 1,000$). If S1 position 4 is used then a reading of 10 should be obtained on the C-R-L dial. $100 \times 10 = 1,000$, but due to the tolerances mentioned above, balance may not be the same although it will be close to it. Commercially manufactured bridges of this type can have accuracies of 1% for resistance and capacitance in the intermediate multiplier ranges and 2% for inductance. However, at the low and high multiplier ranges the accuracies may be only within 5% for re-

★
ERRATA

"The Nature of Matter," Lecture No. 1, Jan. 1970, "A.R." The centre and right hand drawings on page 9 should each have a dot in the outer circle. Also, on page 10, the symbol for Lithium should be Li and for Silicon Si.

"Electric Current and Ohms Law," Lectures 2 and 3, Feb. "A.R.," page 10: In the working out of the example in col. 3, $\dots + \frac{R_4}{1}$ should be $\dots + \frac{R_4}{R_4}$

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S.W.R. Indicators—Trick or Treat?

COL HARVEY,* VK1AU

Over the years, experiments with Yagis and Quads have occasionally shown inconsistencies between S.W.R. Bridge readings and maximum radiation as shown by a **Field Strength Meter**. Although some of these effects can be blamed on feedline radiation, others remain unexplained other than as some inadequacy in the design or location of the s.w.r. meter. Discussion on the air shows that despite such anomalies (which few seem to be aware of) the s.w.r. meter is well regarded by many Amateurs and thought to be incapable of providing misleading information.

The following practical results show that the instrument can confuse and mislead, and that it might be wise to hedge one's bets on the infallibility of assumptions based primarily on s.w.r. readings.

Take the case of a three element plumber's delight on 21 MHz. built to A.R.R.L. formulae except that all elements were intentionally lengthened 5 inches. It was gamma fed, with the s.w.r. bridge at the transmitter end of a 66-foot length of co-ax. A frequency versus s.w.r. run gave the following results:—

21200 KHz. S.W.R.	2.4
21300 " "	2.0
21400 " "	1.8
21500 " "	1.2

Table 1.

The inference one is entitled to make is that the s.w.r. would drop to a very low value outside the high end of the band, i.e. the array is too short. Let us now lengthen all elements 4 inches. A frequency versus s.w.r. run now gave the following result:—

21000 KHz. S.W.R.	1.6
21200 " "	1.3
21300 " "	1.0
21350 " "	1.1
21400 " "	1.2
21500 " "	1.5

Table 2.

One would now conclude that the array is tuned and properly matched at 21300 KHz. But is it? Results show only fair forward gain, poor directivity and negligible front-to-back ratio. Despite this, the s.w.r. meter says that the array is just fine!

On the basis that a change in inter-element spacing to the optimum values for maximum forward gain might improve matters, and on the assumption that the element lengths were now fairly right, the reflector was moved slightly (to 0.25 wavelength spacing). Result:—

21000 KHz. S.W.R.	3.2
21100 " "	3.0
21200 " "	2.9
21300 " "	2.6
21400 " "	2.3
21500 " "	1.8

Table 3.

Could it be that a small change in inter-element spacing had so seriously detuned the beam that it was now resonating well outside the high edge of the band? Surely, with all elements already 9 inches longer than the formulae it couldn't possibly be true that another 7 or more inches was needed to bring the beam back into the band? If the s.w.r. meter indications were right, then the formulae were about 10% out—a fairly unlikely proposition. Something else must be wrong.

Perhaps the four half wavelength feeder wasn't 75 ohms? Terminating the feeder with 52 ohms gave an s.w.r. of 1.4. Terminating with 75 ohms gave an s.w.r. of 1. The feeder was 75 ohms all right. At this point an interesting observation was made. If the s.w.r. bridge was set to the 52 ohm position and an s.w.r. versus frequency run repeated, instead of the result in Table 3, the readings became:—

21000 KHz. S.W.R.	2.3
21100 " "	2.4
21200 " "	2.5
21300 " "	2.7
21400 " "	2.7
21500 " "	3.8

Table 4.

Compare Tables 3 and 4. Table 4 suggests that the beam is outside the low end of the band, Table 3 outside the high end! Obviously the shape of an s.w.r. curve doesn't necessarily indicate anything useful.

If anything is to be made of s.w.r. readings it is obviously imperative to start with an almost flat line of a known impedance. Measurements showed that the 66 ft. length of co-ax was in good condition with only 2 db. loss (see A.R.R.L. Antenna Handbook, page 55). It gave a fair resonance dip on the g.d.o. at 21 MHz. (and a very good dip near 14 MHz.—presumably the free space resonant point of the outer shield). With 75 ohms at the far end, s.w.r. was 1:1.

Now to check out the balun. The traditional formula for a co-ax. balun is $462 \div F_{MHz} \times \text{Velocity Factor}$. Assuming 66% for the velocity factor, the length of the balun should be about 15 feet. However, at this length, the g.d.o. showed resonance well above 21 MHz., and it was necessary to add about 3 feet to the co-ax. to reach the correct length for 21 MHz. Apparently the velocity factor of this particular cable

was well above the traditional 66%. The evidence of the g.d.o. seems conclusive, as the observed dip moved smoothly from 26 MHz. to 21 MHz. as the length was increased.

The stage had now been reached where either 75 ohms at the end of the co-ax feeder, or 300 ohms across the 4:1 balun resulted in an s.w.r. of 1:1. With the feed arrangements proven, the antenna was set up to the lengths required. Using the A.R.R.L. Antenna Handbook, it is possible to select the exact formulae appropriate to the inter-element spacing to be used. With an arbitrary setting on the gamma bars, the first s.w.r. run of the re-arranged array resulted in:—

21000 KHz. S.W.R.	1.0
21100 " "	1.0
21200 " "	1.1
21300 " "	1.8
21400 " "	1.7
21500 " "	2.2

Table 5.

It was difficult to resist the temptation to shorten the antenna elements and so raise the frequency at which the s.w.r. would drop to 1:1. Instead, attention was directed only to the gamma match. The effect of two values of series capacitance was as follows:—

F KHz.	Series Capacitor	
	47 pF.	28 pF.
21000 S.W.R.	1.1	1.4
21100 " "	1.1	1.4
21200 " "	1.1	1.2
21300 " "	1.1	1.1
21400 " "	1.3	1.0
21500 " "	1.4	1.0

The impedance bridge applied to the end of the co-ax. now showed a good non-reactive type dip at 21200, and read about 70 ohms. Best of all, on-the-air checks showed a significant improvement over the initial condition when despite a low s.w.r., the antenna element lengths were all wrong. According to one on-the-air report the half power points were plus and minus 20 degrees, and the front-to-back ratio 25 db. This is too good to be true, as 12 db. seems more likely.

The s.w.r. bridge is now left in circuit partly as an aid to tuning for maximum output, but mainly as a way

(Continued on Page 16)

* 18 Leslie Street, Hughes, A.C.T., 2005.

Design Data for Short and Medium Length Yagi-Uda Arrays

INTRODUCTION

The Yagi-Uda array is a popular method of obtaining directional properties in an antenna. From a constructional viewpoint, particularly simple is the uniform array in which the directors are equally spaced and of the same length. Less simple is the solution to the equation which predicts what the performance of a given array is likely to be. The data presented here have been obtained using an I.B.M. 7090 computer to solve the performance equations for a range of geometrical parameters likely to be of practical significance.

THEORY

There are presently two ways in which the operation of Yagi-Uda arrays can be viewed. One view is to regard the radiation pattern as being the result of the interference between the radiation from the driven element and the travelling wave in the array; the analysis by this method for short arrays is very difficult.

The classical approach develops the radiation pattern from the interaction of the radiation from the driven element and a number of short circuited dipoles. It is easier to write down the equations describing the performance in this case. In fact, if Z is the mutual impedance between some given direction element and the driven element, I is the (complex) ratio of the currents between these two elements, and Y, X, W, \dots are the mutual impedances between the chosen directors and each of the other parasitic elements, for this director—

$$Z = YI + XI + WI + \dots$$

There are as many equations of this type as there are parasitic elements, and the whole set must be solved simultaneously. The mechanics of doing this is fairly standard computer work once expressions for the values of Z, Y, X, W, \dots can be found.

PRESENTATION

All the data presented have been made non-dimensional with respect to wavelength, so figures for spacing, conductor diameter and element lengths are fractions of a wavelength. Reference to Table 1 shows that the following parameters are available:

No. of elements in the array:
3-10

Spacing of elements:
0.15, 0.20, 0.25, 0.30.

Conductor diameter:
0.025, 0.05, 0.01, 0.02.

Given any combination of these quantities, the entry in Table 1 gives the element lengths and resulting radiation pattern for maximum gain and a purely resistive feed impedance.

● The original of this article was a paper published in *Electrical Engineering Transactions*, Vol. EE2, No. 1, of March 1968. The précis we have below was prepared by Dr. D. R. Blackman, of Monash University. We extend our grateful thanks to the Author of the original paper, Mr. H. E. Green, M.E., of the Weapons Research Establishment, and to the Institution of Engineers, Sydney, publishers of *Electrical Engineering Transactions*, for their permission to publish this précis and associated tables.

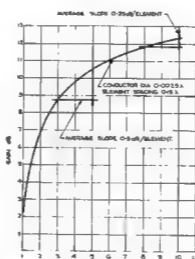


Fig. 1.—Typical Curve of Gain against Number of Elements for Uniform Yagi Array.

STACKED ARRAYS

As is to be expected, the benefit from each succeeding element added to an array decreases. A curve of Gain against Number of Elements is shown in Figure 1; this curve is characteristic of most arrays of the Yagi type. If more gain is wanted than can be obtained with, say, 5 elements, better performance can be more easily obtained by stacking arrays.

If the calculations leading to the results in Table 1 are not to be invalidated, sufficient distance must be left between arrays to preclude interaction between the elements in the separate arrays.

For arrays with the elements coplanar, a centre to centre spacing of not less than 0.75 wavelengths is sug-

gested and for arrays with the elements parallel to spacing of not less than 1.0 wavelength.

PERFORMANCE OF ARRAYS DESIGNED USING TABLE 1

A number of experiments were performed to verify the predictions made in Table 1. The frequency used in these tests was 2.4 GHz. The agreement between theory and experiment was very satisfactory; for more details the reader is referred to the original paper. From a design point of view, these experimental antennae resonate at frequencies 1-2% below the calculated value. In practice, therefore, some slight trimming of elements may be necessary.

The same satisfactory agreement was not obtained with the predicted values of input impedance. The sensitivity of the input impedance of the Yagi is quite notorious, so this lack of close agreement is perhaps not surprising. Moderate mismatching appears to have little effect on the radiation pattern, and in practice the final matching would be made with the aid of a s.w.r. bridge anyway.

In the case when a metallic centre support is used some correction to the lengths of the elements is necessary. A suggested figure is to lengthen elements by $0.75 \times$ diameter of the support; this will tend to give elements which are too long and may consequently need trimming.

Table 1 is shown on page 14 and is continued on page 15.

WORLD'S FIRST COLOUR T.V. TELEPHONE UNVEILED

The world's first colour t.v. telephone has been developed by Tokyo Shibaura Electric Company (Toshiba).

It will be displayed at Expo '70 by the Nippon Telegraph and Telephone Public Corporation.

The device consists of an ordinary telephone for conversation plus a 12" colour picture tube in the centre, with a television camera and a 3" black-and-white monitor tube arranged on it.

The moment the telephone receiver is lifted by the person called, the image of his bust appears on the 12" colour t.v. screen, while the caller can see his own image on the monitor screen.

If the self-view button is pressed, the called speaker's image is replaced with the caller's, enabling him to monitor his own image as viewed at the other end of the wire.

The trial-manufactured set is fairly large, says the Company, 52 centimeters high, 57 centimeters wide and 47 centimeters deep. But Toshiba claims that it can be reduced to about two-thirds by using integrated circuits and smaller picture tubes.

TABLE I.

Tabulation of the Characteristics of Uniform Yagi Arrays.

No. of elements	Spacing	Conductor diameter	Lengths			Gain (db.)	Front to back ratio (db.)	Resistance (ohms)	Polar diagram									
			Reflector	Driven element	Directors				H Plane				E Plane					
									1st Null		1st Side lobe		1st Null		1st Side lobe			
									3 db BW	Position	Level	Position	Level	3 db BW	Position	Level	Position	Level
3	0.15	0.0025	0.4931	0.4738	0.4764	9.4	7.8	3.1	68*	71.5*	12.1	90*	9.9	52*	90*	-40.0	116.5*	-22.0
	0.20		0.4883	0.4659	0.4603	9.8	6.7	7.8	66	70.5	19.2	99	11.0	52	99.5	-60.0	115	23.0
	0.25		0.4812	0.4594	0.4597	9.5	5.7	18.1	71	74	-16.0	99.5	13.0	53	78.5	-60.0	81.5	-38.5
	0.30		0.4764	0.4543	0.4502	8.6	4.7	38.0	80	78	-17.1	98	-13.4	58	90	40.0	115.5	-24.5
	0.35																	
4	0.15		0.4683	0.4685	0.4597	9.7	8.3	19.2	71	74	-16.0	98	-12.7	54	90	40.0	112.5	-26.1
	0.20		0.5026	0.4765	0.4653	10.2	14.4	9.3	59	62	-10.9	83	-9.5	46	90	40.0	121	-22.3
	0.25		0.4907	0.4679	0.4621	11.2	13.5	15.5	56	57	-16.4	80.5	-10.4	46	60	-23.3	67	-22.6
	0.30		0.4786	0.4585	0.4590	11.1	7.5	21.5	56	55	-60.0	78.5	-9.9	46	55.5	40.0	69	-22.3
	0.35																	
5	0.15		0.5074	0.4802	0.4621	10.2	16.7	14.1	64	66.5	-14.0	95	-10.4	50	90	-60.0	122	-21.0
	0.20		0.4883	0.4664	0.4573	11.2	12.1	14.8	56	56	-15.2	77.5	-10.4	48	90	-60.0	115.5	-21.6
	0.25		0.4812	0.4579	0.4502	11.1	7.6	35.3	56	54	-60.0	77	-9.5	46	54.5	-60.0	68	-21.2
	0.30		0.4635	0.4664	0.4573	12.3	18.6	21.2	46	45	-17.6	65	-8.8	46	46	-21.5	59	-18.6
	0.35																	
6	0.15		0.4995	0.4707	0.4528	11.0	15.7	13.7	58	59.5	-14.5	81.5	-11.1	48	90	-60.0	125	-24.6
	0.20		0.4835	0.4630	0.4554	12.4	15.3	24.5	46	45	-16.4	80.5	-10.2	46	55	-31.9	67.5	-21.8
	0.25		0.4859	0.4662	0.4526	12.5	17.4	21.5	46	46.5	-18.3	65.5	-9.5	43	47	-22.4	59.5	-17.5
	0.30		0.4764	0.4580	0.4454	11.7	7.2	42.1	48	45	-27.4	64	-8.4	43	45	-31.8	59	-18.2
	0.35																	
7	0.15		0.4859	0.4663	0.4454	11.4	9.3	32.5	54	54.5	-16.4	75	-10.5	46	56.5	-22.3	65	-21.3
	0.20		0.4931	0.4666	0.4502	12.1	16.9	16.9	48	47	-15.9	67	-9.3	42	48.5	-20.1	59.5	-17.5
	0.25		0.4788	0.4604	0.4431	12.1	8.5	35.5	46	45	-16.7	83.5	-9.6	40	43	-20.0	59.7	-16.7
	0.30		0.4768	0.4611	0.4476	13.0	13.3	29.5	40	39	-24.1	58	-8.6	37	39.5	-26.6	53	-14.5
	0.35																	
8	0.15		0.4931	0.4794	0.4454	11.9	13.6	28.2	31	51	-16.4	72.5	-9.0	44	52	-21.3	63.5	-19.1
	0.20		0.4859	0.4637	0.4407	12.4	29.3	31	46	45.5	-22.8	64	-9.5	42	46	-26.5	59.5	-17.3
	0.25		0.4835	0.4637	0.4478	13.1	35.7	24.6	40	39	-17.4	59	-9.5	36	39	-20.1	52	-14.1
	0.30		0.4812	0.4667	0.4536	13.2	30.4	26.6	34	33	-13.4	48	-7.2	32	33	-15.4	45	-11.5
	0.35																	
9	0.15		0.4931	0.4715	0.4407	12.1	25.0	17.5	48	47.5	-16.0	67	-9.7	42	49.5	-20.4	60.5	-18.2
	0.20		0.4907	0.4721	0.4478	12.7	34.3	22.5	40	39.5	-13.6	56	-8.0	36	40.5	-21.5	53	-13.6
	0.25		0.4788	0.4638	0.4407	12.9	8.5	35.8	40	38	-27.3	34	-8.5	36	38	-29.3	51.5	-19.4
	0.30		0.4764	0.4579	0.4407	13.4	9.9	39.3	37	35	-39.1	44.5	-8.3	34	35	-36.0	47.5	-12.9
	0.35																	
10	0.15		0.4907	0.4664	0.4335	12.5	13.4	22.9	46	46	-19.5	64.5	-9.7	42	44.5	-23.2	59.5	-17.6
	0.20		0.4859	0.4648	0.4383	13.2	15.4	25.5	40	39.5	-19.4	59.5	-9.0	37	40	-22.3	52.5	-14.4
	0.25		0.4812	0.4654	0.4367	13.7	20.0	29.2	37	38.5	-21.0	50	-8.7	34	38	-23.2	47.5	-13.4
	0.30		0.4768	0.4624	0.4454	14.1	18.8	31.1	32	31	-17.4	64	-7.7	30	31	-19.1	42.5	-11.5
	0.35																	
11	0.15	0.0050	0.4912	0.4689	0.4723	9.4	7.8	2.9	68	70.5	-12.2	96	-9.8	52	90	-60.0	117	-22.0
	0.20		0.4885	0.4603	0.4626	9.8	7.2	7.9	69	72	-19.0	99	-11.5	53	90	-60.0	115.5	-23.3
	0.25		0.4794	0.4560	0.4510	9.5	6.3	18.4	74	76	-60.0	100.5	-13.6	56	99.5	-60.0	111	-23.6
	0.30		0.4747	0.4469	0.4416	8.7	5.1	39.7	81	78.5	-16.2	99	-13.0	59	99.5	-60.0	114.5	-24.9
	0.35																	
12	0.15		0.4865	0.4591	0.4534	9.7	8.4	19.0	70	74	-17.1	98.5	-12.6	54	90	-60.0	115	-26.7
	0.20		0.5030	0.4710	0.4638	10.2	15.9	11.4	64	64.5	-12.3	88.5	-10.5	49	90	-60.0	123.5	-21.2
	0.25		0.4905	0.4626	0.4538	11.2	13.7	12.7	56	57	-16.0	79.5	-10.6	46	60.5	-22.8	66.5	-22.5
	0.30		0.4747	0.4530	0.4463	11.1	8.4	21.7	57	57	-60.0	79	-10.5	48	57	-60.0	69.5	-23.2
	0.35																	
13	0.15		0.5054	0.4784	0.4508	10.2	17.0	13.3	64	67	-13.8	94.5	-10.6	50	90	-60.0	123	-21.0
	0.20		0.4895	0.4616	0.4487	11.2	13.5	14.7	56	57.5	-18.3	79	-11.2	47	61	-23.1	64	-22.9
	0.25		0.4770	0.4514	0.4416	11.1	7.9	33.1	56	55	-27.9	77	-9.7	47	58	-20.0	64.8	-18.6
	0.30		0.4817	0.4599	0.4510	12.2	15.4	18.4	44	46	-16.5	64.5	-8.5	40	45	-20.3	58	-16.1
	0.35																	
14	0.15		0.4912	0.4652	0.4463	11.0	15.3	12.3	57	59	-13.5	78	-10.9	48	90	-60.0	126.5	-23.4
	0.20		0.4817	0.4565	0.4369	11.3	9.0	34.7	56	54	-27.4	76.5	-10.1	46	55	-32.4	68	-21.7
	0.25		0.4841	0.4589	0.4463	12.3	15.0	19.4	46	45.5	-16.9	64.5	-9.0	40	46	-20.8	58.5	-18.8
	0.30		0.4723	0.4487	0.4369	11.7	7.2	40.4	48	45	-27.4	64	-8.4	42	45	-31.5	59	-18.1
	0.35																	
15	0.15		0.4865	0.4606	0.4322	11.4	11.2	20.5	56	56.5	-19.7	78	-11.2	47	58	-25.8	68	-23.4
	0.20		0.4888	0.4631	0.4448	11.9	19.0	17.3	46	46	-14.4	65	-9.0	40	47.5	-18.4	58	-18.8
	0.25		0.4770	0.4535	0.4345	12.1	8.8	40.2	46	45	-38.5	63.5	-8.9	42	45	-40.0	59	-18.3
	0.30		0.4747	0.4530	0.4392	13.0	13.6	28.5	40	40	-24.6	56	-8.7	37	40	-27.3	53	-14.5
	0.35																	
16	0.15		0.4936	0.4756	0.4392	11.5	15.1	23.4	50	50	-15.0	71.5	-9.8	44	52	-19.8	62.5	-18.3
	0.20		0.4817	0.4595	0.4322	12.4	10.2	27.8	46	45	-22.0	63.5	-8.5	41	46	-25.5	59	-17.2
	0.25		0.4817	0.4578	0.4392	12.4	16.1	24.2	46	45	-25.8	63.5	-8.5	39	39	-20.0	62.5	-14.2
	0.30		0.4774	0.4627	0.4440	13.2	20.0	29.3	34	33.5	-14.6	66.5	-7.3	32	34	-16.7	40	-11.7
	0.35																	
17	0.15		0.4912	0.4663	0.4322	12.1	24.3	16.5	48	47.5	-15.5	66.5	-9.7	42	49	-20.1	59.5	-18.1
	0.20		0.4898	0.4673	0.4392	12.7	23.8	22.0	40	39.5	-13.8	56	-8.1	36	40	-16.8	52	-13.9
	0.25		0.4747	0.4577	0.4298	12.8	9.2	43.0	40	39	-31.5	54.5	-8.7	37	39	-35.8	51.5	-14.2
	0.30		0.4747	0.4507	0.4322	13.3	10.1	39.0	37	35	-39.3	49.5	-8.2	34	35	-36.2	47.5	-12.8
	0.35																	
18	0.15		0.4865	0.4613	0.4327	12.5	13.5	20.7	46	46	-30.0	64.5	-10.0	42	47	-23.7	60	-18.0
	0.20		0.4841	0.4581	0.4308	12.2	13.5	24.8	40	39	-21.4	59	-8.6	36	36	-21.4	50	-17.5
	0.25		0.4817	0.4559	0.4345	13.8	19.5	27.1	36	34	-17.2	65.5	-8.1	33	34	-19.2	46.5	-12.4
	0.30		0.4770	0.4563	0.4369	14.0	18.8	30.5	32	31	-17.4	43.5	-7.7	30	31	-19.1	42.5	-11.3
	0.35																	
19	0.15	0.0100	0.4896	0.4624	0.4460	9.4	8.5	3.1	70	74.5	-12.1	96.5	-10.6	54	90	-60.0	117.5	-22.5
	0.20		0.4826	0.4518	0.4466	9.6	7.2	7.5	69	72	-1							

TABLE L—(contd.)

No of elements	Spacing	Conductor diameter	Lengths			Gain (db.)	Front to back ratio (db.)	Resistance (ohms)	Polar diagram														
			Reflector	Driven element	Director				H Plane						E Plane								
									1st Null			1st Side lobe			1st Null			1st Side lobe					
									3 db.	Position	Level	Position	Level	3 db.	Position	Level	Position	Level	3 db.	Level			
7	0.15	0.0100	0.4826	0.4322	0.4197	11.4	11.1	19.4	56	47	56.5	19.6	77.5	-11.2	47	58	25.6	68	-23.2				
	0.20		0.4873	0.4561	0.4312	12.1	12.0	19.4	46	47	56.5	19.6	77.5	-11.2	47	58	25.6	68	-23.2				
	0.25		0.4841	0.4441	0.4220	12.1	12.1	19.4	46	45	56.5	19.6	77.5	-11.2	47	58	25.6	68	-23.2				
	0.30		0.4710	0.4432	0.4200	13.0	12.0	25.8	40	39	22.2	55	8.4	38	39	-24.7	52.2	-14.0					
8	0.15		0.4843	0.4692	0.4200	11.5	11.3	20.2	50	49.5	14.2	71	8.7	44	52	19.0	61	-18.0					
	0.20		0.4780	0.4677	0.4173	12.4	11.4	20.2	46	46	28.1	64	9.7	42	46	27.3	60	-17.5					
	0.25		0.4780	0.4601	0.4267	13.1	11.9	20.2	40	39	18.4	57.5	8.6	36	39.5	21.0	52.5	-13.0					
	0.30		0.4730	0.4529	0.4337	13.2	12.1	25.3	35	35	13.7	48	7.2	32	33	15.7	45.5	-11.3					
9	0.15		0.4873	0.4593	0.4173	12.6	11.9	13.5	48	50	-19.2	62.5	11.8	42	51	23.8	62	-20.7					
	0.20		0.4873	0.4605	0.4267	12.7	12.0	21.9	40	40	-14.4	56.3	8.2	37	40.5	-17.2	52.5	-14.1					
	0.25		0.4686	0.4668	0.4173	12.9	12.1	41.2	40	38	28.0	54.3	8.5	36	38.5	29.5	52	-14.0					
	0.30		0.4663	0.4797	0.4197	13.4	12.4	35.7	36	35	29.2	49	9.3	34	31	-31.2	47.5	-12.6					
10	0.15		0.4826	0.4527	0.4103	12.5	12.9	19.9	46	46	18.9	64	9.8	42	46.5	22.5	59	-17.6					
	0.20		0.4803	0.4500	0.4150	13.2	13.5	23.4	40	40	19.9	55.5	9.1	37	40	-23.6	52.5	-14.8					
	0.25		0.4756	0.4483	0.4197	13.7	13.4	26.6	36	35	19.9	49.5	8.5	34	33	-21.9	47.5	-13.0					
	0.30		0.4710	0.4466	0.4243	14.2	13.3	28.0	32	31	16.8	44	7.7	30	31	-18.4	42.5	-11.3					
3	0.15	0.0200	0.4640	0.4502	0.4543	9.4	7.9	2.6	68	71	12.4	97	10.0	53	90	-40.0	116.5	-22.5					
	0.20		0.4546	0.4394	0.4406	9.8	7.2	6.9	69	72	18.5	99	11.6	54	90	-40.0	114.5	-23.6					
	0.25		0.4657	0.4301	0.4266	9.5	15.0	7.4	74	76	10.0	12.6	78	40.0	52	-23.8	116.5	-23.8					
	0.30		0.4749	0.4181	0.4132	8.7	4.8	28.9	79	77	16.8	98	12.8	58	90	-40.0	113	-23.3					
4	0.15		0.4771	0.4368	0.4269	9.3	8.5	16.0	70	74.5	17.8	99	12.7	54	90	-40.0	115	-24.8					
	0.20		0.4777	0.4553	0.4429	10.3	15.3	7.8	79	62	10.9	81.5	9.9	48	90	-40.0	124	-21.9					
	0.25		0.4771	0.4411	0.4315	11.2	13.6	10.9	56	37	16.0	79.5	10.9	46	60.5	-32.6	66	-22.3					
	0.30		0.4613	0.4247	0.4281	11.1	7.4	17.4	56	38	16.0	78	8.7	46	55.5	-40.0	66.5	-21.9					
5	0.15		0.5023	0.4587	0.4338	10.2	16.5	8.3	62	66	12.4	99	10.7	50	90	-40.0	122.5	-21.7					
	0.20		0.4794	0.4394	0.4224	11.2	12.6	12.6	56	54.5	16.0	78	10.6	46	60	-22.5	54	-22.5					
	0.25		0.4634	0.4252	0.4109	11.1	7.6	28.2	36	39	38.9	77	9.7	48	25	-40.0	68	-21.9					
	0.30		0.4680	0.4363	0.4246	12.2	15.6	15.7	44	44	16.5	64	8.6	46	45	-20.1	58	-18.1					
6	0.15		0.4863	0.4459	0.4155	11.0	16.4	11.1	58	60	14.9	81	11.4	48	90	-40.0	126	-24.9					
	0.20		0.4680	0.4336	0.4064	11.3	8.7	30.4	54	54	25.6	78	10.0	46	54	-29.8	87.5	-21.3					
	0.25		0.4728	0.4366	0.4178	12.3	15.9	18.5	46	46	16.0	64	9.8	46	46	-20.6	58.5	-15.7					
	0.30		0.4749	0.4430	0.4292	13.9	20.5	15.5	36	34.5	9.4	51.8	-4.0	34	36	-11.7	40.5	-10.6					
7	0.15		0.4771	0.4381	0.3995	11.4	11.1	17.9	56	56	19.7	77.5	-11.1	47	57.5	25.4	58	-23.0					
	0.20		0.4771	0.4428	0.4132	12.2	20.2	15.5	46	46.5	-13.1	65.5	9.3	42	48	-19.2	59	-17.2					
	0.25		0.4612	0.4286	0.4018	12.1	8.5	34.3	40	59	32.0	63	8.9	42	48	-36.0	59	-16.3					
	0.30		0.4612	0.4290	0.4067	13.0	12.9	25.8	40	59	23.7	59.5	8.6	36	39	-29.9	53	-14.2					
8	0.15		0.4886	0.4580	0.4109	11.8	16.7	11.1	50	49	13.6	70.5	-8.9	44	52.5	-18.6	80.5	-17.9					
	0.20		0.4703	0.4325	0.3972	12.4	11.0	23.7	46	45	-25.6	63.5	9.5	42	48	-19.9	59.5	-17.2					
	0.25		0.4703	0.4252	0.4064	13.1	17.3	21.3	40	39	11.8	52.5	8.7	36	40	-19.4	52.5	-16.4					
	0.30		0.4657	0.4392	0.4195	13.2	22.9	22.9	34	33	13.4	67.5	-7.2	33	33.5	-15.3	45.3	-11.3					
9	0.15		0.4840	0.4659	0.3995	12.2	22.7	13.9	48	47.5	15.4	66	9.7	42	49	-15.8	59.5	-17.8					
	0.20		0.4781	0.4491	0.4064	12.7	22.5	30.5	40	40	14.8	57	8.3	37	41	-17.6	53	-16.2					
	0.25		0.4612	0.4330	0.3972	12.9	9.3	38.5	38	38	26.7	54	8.4	36	38	-24.4	51	-15.8					
	0.30		0.4566	0.4237	0.3972	13.4	18.8	32.0	37	35	33.5	48.5	-8.3	34	35	-14.2	47.5	-12.7					
10	0.15		0.4771	0.4393	0.3858	12.5	13.4	17.7	46	46	20.2	64.5	-16.0	42	47	33.7	50.5	-17.9					
	0.20		0.4726	0.4358	0.3927	13.2	15.4	21.0	40	46	19.9	53.5	-9.1	37	40	-22.5	53.5	-14.8					
	0.25		0.4680	0.4330	0.3995	13.8	17.5	23.2	36	34.5	17.9	48.5	-8.3	33	35	-20.0	47	-12.6					
	0.30		0.4657	0.4311	0.4041	14.2	18.1	25.8	32	31	16.9	44	-7.7	30	31	-18.5	42	-11.2					

S.W.R. INDICATORS

(Continued from Page 13)

of knowing if some mechanical fault has developed in the feeder. A short across the far end of the feeder will show only about 2:1.

GUIDE LINES

On the basis of this project, the following guide lines seem relevant:—

- **Element Spacing.**—Go for wide spacing, reflector at least 0.2 wavelength, director 0.25 wavelength. This can replace the 2 db. loss inherent in co-ax. feedline.
- **Driven Element.**—There is a great temptation to set it to resonance using a radiated signal and a diode meter combination across intended feed point. Don't do it! For gamma feed, the radiator needs to be a little short.
- **Reflector.**—Too much enthusiasm for front-to-back ratio will reduce forward gain slightly. But even the best front-to-back ratio will

only cost you about 3 db. in forward gain. In VK it's usually best to go for maximum forward gain.

- **Gamma Bar.**—Increasing the spacing of the bar from the radiator raises the impedance range of the bar. Also, shortening the radiator will raise the antenna feed point impedance. Since a lot of work will be needed to optimise the options available, it's better to rely on the formulae for radiator length, adding only the gamma match for maximum radiated signal. Don't forget to provide some series capacity to offset the inductive reactance of the gamma bar.
- **Design Frequency.** Design and tune up on a frequency 100 KHz. lower than the spot you wish to operate on most. The array will increase in frequency when raised above ground to its intended operating height.
- **Test Equipment.** Use a simple Antenna Bridge, a G.D.O., and a remote indicating Field Strength Meter, initially. Rely on these, rather than a S.W.R. Bridge.

TECHNICAL ARTICLES

Readers are requested to submit articles for publication in "A.R." in particular constructional articles, photographs of stations and gear, together with articles suitable for beginners, are required.

Manuscripts should preferably be typewritten but if handwritten please double space the writing. Drawings will be done by "A.R." staff.

Photographs will be returned if the sender's name and address is shown on the back of each photograph submitted.

Please address all articles to:

EDITOR "A.R."
P.O. BOX 38,
EAST MELBOURNE,
VICTORIA, 3002

REPORT TO FEDERAL COUNCIL (1970)

Gentlemen

It is my pleasure to present the report on behalf of the Federal Executive on its activities subsequent to the 18th Federal Convention. Whilst our financial year now ends on the 31st December, this report deals with the activities of the Federal Executive to date.

To present this report gives me particular pleasure. It is a privilege to be able to report to you that the last year has been one of the most successful and productive in the history of our Federation. Secondly, successful year just passed is a fitting start for 1970, the year that marks the 60th anniversary of the Wireless Institute of Australia, and I have every reason to believe that 1970 will be a year more successful than the year just passed. In my mind there is no doubt that an active and effective organisation must continue to attract new members, and equally, our organisation cannot hope to be active and effective without the hearty support of the Australian Amateur population. I now turn to particular topics.

• 1969 N.Z.A.R.T. BI-CENTENARY CONFERENCE AT GISBORNE

The Federal Council resolved, at the 18th Federal Convention, to accept the invitation of N.Z.A.R.T. to be represented at this most important Conference, and it was my privilege to represent you there. I was invited to address the Conference, which I did, on Saturday, 21st May. A copy of my address was reproduced in "Amateur Radio" the official journal of N.Z.A.R.T., as well as in our own journal, "Amateur Radio". After my return on 26th June, I reported in detail to the Federal Council on this visit. The personal contact that this visit produced resulted in a frank and helpful exchange of views between the two organisations. More tangibly, it also resulted in the exchange of publications between N.Z.A.R.T. and I.A.U. By February 1970 we were sending 33 copies of "Amateur Radio" to our New Zealand subscribers, N.Z.A.R.T. handling the subscription and forwarding the copies to its members. The personal contacts initiated by this visit have continued, as I have been able to keep fairly regular "contact" on matters with the N.Z.A.R.T. President, Bill Hamer ZL4CD May 1. In this report, once again record my deep appreciation for the hospitality and kindness that I received from the New Zealand Amateurs whilst I was in their country.

One matter that is to be raised by this Federation is the possibility of altering the rules for the Remembrance Day Contest to enable the New Zealand Amateurs to participate. I believe that a favourable decision by the Federal Council on this matter would be very much appreciated by the New Zealand Amateurs, so many of whom expressed to me regret that they were unable to participate in this, the premier Contest in our part of the world. Their participation can only be brought about by the Council of the two organisations, which I believe is in the interests of both organisations.

• REPRESENTATION

At the 18th Federal Convention, the Federal Council expressed the view that closer representation between the Federal Executive and the Divisions was desirable. I have taken every opportunity that has been open to me to pursue this policy, and I believe that the increasing personal contact our activities in the Federal sphere can be seen so easily as something remote and distant from our membership. In the course of my journey home from New Zealand, I met and conferred with the Federal Council of the New South Wales Division, the Council of the New South Wales Division, and on Friday, 18th July, I attended a Council meeting of the South Australian Division in Adelaide, and on the following day, 19th July, I met the members of the Victorian and New South Wales Zones. On 17th October, in the course of a visit to Sydney, I conferred with the Council of the New South Wales Division, and on the follow-

ing day conferred with the Federal Representative Secretariat.

On Friday, 20th November, I addressed a General Meeting of the Queensland Division in Brisbane, and on the following Monday that December I met the Council of that Division. On 4th March 1970 I addressed a General Meeting of the Victorian Division. The total cost to the Institute of these visits to the Divisions has amounted to approximately \$100. I believe that a continuing personal contact between the Executive and the Divisions throughout the year of fundamental importance. It is too easy for the Federal Executive to be seen as seven faceless men, remote from the everyday life of Amateur Radio. What our Federal Organisation doing is of basic importance to all Amateurs. Our Federal body represents all Amateurs everywhere, and an understanding of these activities can only come from personal contact.

In addition, I have now acquired a far deeper insight of the peculiar problems that face each Division that I could have gained. I am quite convinced that many of the conflicts and misunderstandings of the past would have been avoided had personal contact been possible at those times. I believe that it is in the interest of our organisation for the future that this contact be continued.

To the Federal Councillors, to the Presidents, to the Councils, and to the members of those Divisions that I was able to visit in the last year, may I express my appreciation for their hospitality, patience and courtesy.

• THE YEAR AHEAD

A considerable amount of time and effort has been devoted to planning for 1970. The Australian Tourist Commission provided, free of charge, 100,000 1970 calendar cards for distribution to Australian Amateurs through the Divisions. That number, large as it was, was merely a start, for, for the plates prepared for the Australian Tourist Commission, the printing of which was paid for by individual members, the Executive has arranged to have 10,000 more printed. I extend our heartfelt thanks for their most generous gesture in providing so many Amateurs with a useful and attractive calendar.

The rules of the Cook Bi-Centenary Award were published in August "Amateur Radio", and a handsome Certificate has been presented to the winner. The rules of the Committee of the January "Amateur Radio". Copies of the rules of this Award were circulated to over seventy overseas societies and publications. A thousand copies of the Cook Bi-Centenary Award Certificate have been printed. It is our sincere hope that the rules as they are printed will prove to be quite insufficient and it seems that this is quite likely. In addition, from 1st January 1970 to the end of 1970, Australian Amateurs are permitted to use the alternative prefix "AX", and the use of this prefix is an integral part of the rules of the Cook Bi-Centenary Award.

The success of the Award and the "AX" prefix became immediately obvious on 1st January 1970, and the success has been priced at the very real interest that has been created—indeed I think it can be said that this Award has created more activity than any other single thing for many years.

The rules of the Cook Award have been the subject of some discussion. They have been tailored to provide an award attractive to overseas Amateurs. Various suggestions have been made to add specialised sections to the Award. Executive has accepted the advice of the Award Committee, and has decided to merely complicate the rules to serve a very small minority at the expense of sacrificing basic simplicity. A very few members have been required, though because of the diversity of views as to how the rules for such an award should be framed, the formulation of the Award rules for the next year will be a considerable difficulty. The matter has been left in the hands of the Federal Vice-President and the Award Committee, and will be decided by the Federal Council at the Federal Convention.

The role to be played by Divisions in 1970 is indeed important and once again I urge all Divisions to make their activities in 1970 a year bearing in mind the special significance of this year for Amateur Radio, particularly highlighting the 80th Anniversary of our organisation.

• CONFERENCE FOR SPACE TELECOMMUNICATIONS

As you know, a World Administrative Radio Communications Conference for Space Telecommunications has been set down to open in Geneva in June 1971. The significance of this Conference cannot be underestimated and on its own initiative, the Federal Executive has prepared and circulated a confidential and comprehensive report to Federal Council. It will be the task of the 18th Federal Convention to formulate the Institute's policy in relation to the 1971 Conference.

The report prepared by Federal Executive was the product of a week-end in November when various persons were consulted. In addition, a considerable body of material has been annexed to the report to assist the Federal Council in reaching a view. Federal Executive has suggested a policy for consideration by Federal Council as a tangible starting point in its considerations. This matter has occupied a very considerable part of the Executive's time during the past few months, sometimes to the detriment of other matters, but I think that the importance of this Conference more than justified the time that has been devoted to it. Whilst June 1971 may seem to be a long way in the future now, there is no alternative but to prepare now.

I would like to thank the Federal Councillors of those Divisions that submitted material, to the members of the Federal Executive who assisted in preparing the report, the Federal Representative Secretariat, the Federal Vice-President, and the very many other people who gave of their time to offer their views and expertise to the Executive.

• "AMATEUR RADIO"

Whilst the Institute's publications will be the subject of a separate report from the Editor, Mr Ken Pincock who is now a member of the Federal Executive, I would like to observe in passing that the magazine has been brought to me on the greatly improved standard that has been attained by our magazine during the past year. The additional funds obtained through the last price increase have been used to excellent advantage, and I am sure that all our members would join with me in expressing to Ken and to the Publications Committee our congratulations on a job well done.

It is gratifying to be able to report that for the first time this year, articles published in "Amateur Radio" are being reprinted by other magazines, including "Radio and Communications", "CQ Magazine" and the journal of the Dutch Amateur Radio Society.

"Amateur Radio" is the only direct means of communication the Executive has to our Australia-wide membership. I have attempted in writing "Federal Comment", to deal with interesting subjects of wide interest, have been "overly hard" it is to write "Federal Comment", though this year I suspect the task has been made a little easier, because there have been so many long and interesting letters for writing about. I have been heartened by the fact that so many people do, in fact, read "Federal Comment" and are prepared to express their views on the matters there raised.

• MEMBERSHIP

The following table has been compiled based on membership figures as at 30th December, 1969:

			Members as against		
	Total Licen-	Full	Total	Total	
	Membs	Licenses	Membs	Licenses	Membs
VKX	1263	1081	55%	602	1381
VKX	1283	940	30%	276	1100
VKX	694	350	31%	144	499
VKX	348	418	38%	340	690
VKX	403	302	01%	60	370
VKX	239	148	64%	114	200
Totals	3089	2108	54%	1238	4086

Our total percentage of full members as against total licences of 54% is obviously capable of improvement. On the other hand these figures compare favourably with most overseas societies. It is interesting to note, for example, that N.Z.A.R.T. attracts only a 48% membership. I can see no reason why we should not aim for a 60% membership and I commend this to the consideration of Divisional Councils.

Following the resolution of the Federal Council to change the financial year of the Institute to the calendar year to enable the easier preparation of accounts for the Federal Convention, the necessary amendment to the Federal Constitution was passed, all Divisions voting in favour of the amendment.

As you will recall, the last outstanding matter that concerned the Divisions in relation to the Memorandum and Articles of Association was the question of the incorporation of the Articles making provision for a postal referendum of all members throughout Australia on a decision of a majority of Divisions. For legal reasons, the inclusion of these provisions was not possible in the original Council meeting of the 1968 Convention, resolved to ascertain whether a different attitude would be adopted by the appropriate authorities in New South Wales. I am glad to say that the New South Wales Division has been advised that a similar attitude would be adopted in that State. The Federal body would be incorporated omitting these provisions if this occurred. I have asked the Council to resolve that the same attitude in the circumstances now existing and I am awaiting their reply. I am very hopeful that once the Constitution Committee of the Council has been consulted, the outstanding matter, incorporation will be able to be proceeded with without further delay. Then what remains is to call a meeting of the Council, only and the speed of incorporation will be dependent entirely on how quickly the Divisions can agree on the proposed amendments at a meeting of their Council.

The following amounts were to be contributed by each of the Divisions to establish this fund:

At this time, a total of \$8,738.87 is held in the fund with all of the Divisions except the New South Wales Division having attained their quota. Of its target of \$3,800, the N.S.W. Division has paid to Federal Executive \$3,839.

During the year, the Interim Constitution of the I.A.R.U. Region III Association was signed on behalf of Japanese Amateur Radio League, The Philippines Amateur Radio Association, the New Zealand Amateur Radio Transmitters, and the Wireless Institute of Australia, and thus this organization came into formal being.

Preparation for the World Administration Radio Communications Conference for Space Telecommunications, on which I have reported elsewhere, involves a number of discussions with the Department. Under the present heading, I would simply observe that the Assistant Director General (Radio) has indicated that it is his wish that the fullest possible consultation with the Amateur Service should take place. I believe that the sort of consultation contemplated is in the best interests of all concerned.

The 1969 Federal Convention discussed the apparently illegal operation by some persons in the 27 MHz. so-called "citizen band." During the year it appeared that this sort of operation was increasing. At the time, I, as a delegate, was not present. A conference was held with representatives of the Department early this year. Whilst these frequencies are not allocated to the Amateur Service, the identification of these "harmful" stations as Amateur stations is a general public matter of legitimate concern. I believe that the Department will do all in its power to stamp out this sort of operation, which serves to bring the Department into disrepute and causing friction amongst Amateurs.

I also believe that a permanent committee available to assist the Executive on specific tasks will be very useful, and indeed the extension of this principle into other Divisions would seem to be worthwhile. From time to time opportunities arise where such committees can undertake specific tasks which both reduces the work load on the Executive and enables the involvement of more people in our Federal sphere.

One of the Amateur bands which would seem to be under considerable attack (at least in Australia) is the 420-480 MHz allocation. The utilisation of these frequencies for sophisticated and useful experiments, such as Amateur satellites, is one of the best justifications for the retention of these frequencies. In any event, the continued fostering of this sort of activity which is in the interest of Amateur Radio as a whole, is one of the inescapable responsibilities of our organisation.

During the year it became necessary to define with some precision the basis upon which the Federal Repeater Secretariat was appointed and in particular to define the relationship between the Division from which it was appointed and the Federal Executive.

As a result of my discussions with the N.S.W. Division on 17th November, 1960, the following duties of the Secretariat were defined:

- (a) To inform and advise Federal Council, through the Federal Executive, on all matters pertinent to the use of Repeater/Translator stations in the Amateur Service
- (b) To provide assistance to the Federal Executive in liaising with the P.M.C.'s Department Central Office on all matters referred to the committee
- (c) To recommend the use of specific frequencies within the authorised bands for such services
- (d) To formulate standards for the location, design and installation of such stations in order to simplify application to interested Amateurs to the licensing authorities for permission to use these facilities
- (e) To liaise with Divisional Repeater/Translator committees and advise on all matters related to the use of such Repeater/Translator Stations
- (f) To undertake such other tasks as are referred to it by Federal Council.

In addition, the following mechanics of the appointment of the Secretariat and the definition of its responsibilities were spelt out:

"Federal Executive shall call upon that Division to nominate members for the Secretariat, such members to be appointed by the Federal Executive. The Executive may re-constitute the Secretariat at any time at its discretion, or if requested to do so by the Division providing the members of the Secretariat. The Federal Executive will appoint a chairman of the Secretariat who may be appointed a co-opted member of the Executive in accordance with Clause 28 of the Federal Constitution."

Motions to this effect were passed by the Council of the N.S.W. Division and the Federal Executive. Mr. Tim Mims was appointed as co-opted officer and chairman of the Federal Repeater Secretariat. Mr. Ian McKenzie has resigned as a member of the Federal Repeater Secretariat. On 10 October 1969, Mr. Chris Jones resigned so that he could become a member of the N.S.W. Division Repeater Committee and was replaced by Mr. John Ruffa. VK2KZJ I would like to record the Executive's appreciation of Chris' enthusiasm and valuable work on the Federal Repeater Secretariat.

• V.H.F. PROGRESS

During the year progress has continued on the v.h.f. bands, and the following contacts are notable achievements in this part of the spectrum:

On 1296 MHz. VK2BDN worked VK2ZAC over a distance of 148 miles, a band record. On 3765 MHz. VK2KJZ worked VK2QZG over a distance of almost 200 miles. On 432 MHz. VK2KATZ worked VK2ATW. On the 8 metre band, for the first time, the continent has been spanned each way, with VK2KATZ, VK2AMK and VK2ATW, and possibly others, working VK2KJZ in Albany.

• INTRUDER WATCH

The Federal Intruder Watch Co-ordinator, Dr. David Wardlaw, has devoted a considerable effort attempting to create an active Intruder Watch organisation. As will be seen from his report, the response that has been received has been very poor indeed. This surprise would have been thought that many active Amateurs would be prepared to assist in this activity, which I regard as being a very important aspect of our preservation of our frequencies. Nonetheless, the lack of response raises the question for Federal Council as to the necessity for this organisation, and is justified, for there seems to me to be little point in devoting a great deal of energy to an activity which is achieving very little.

• HOW TO BECOME A RADIO AMATEUR

At long last and after many delays, this is with the primary of Ken Pincott, to become available at the end of March. When it is available it will be distributed to the Divisions. This is one task that I am sure Executive has tried to see the end of, and I am glad that this publication will fill a long standing need.

• FEDERAL EXECUTIVE

Between April 1968 and February 1970, the Federal Executive held 13 meetings. The attendance at these meetings was as follows:

M. Owen	13
J. Williams	13
J. Bairstow	11
D. Pither	11
D. Rankin	10
D. Wardlaw	10
A. Seesman	4 (Resigned June 1969)
E. Connolly	3 (Resigned Nov 1969)
W. Roper	4 (Appointed Nov 1969)
K. Pincott	7 (Appointed June 1969)

• WORKLOAD OF FEDERAL EXECUTIVE

During the past year, the Federal Executive has become increasingly concerned at the inordinate workload that is borne by a limited number of people, in particular, by the editor of "Amateur Radio" and by the Federal Secretary. As each year goes by, the responsibility borne by the Federal Executive is increased; even though the workload has been spread and the responsibilities shared as far as is practical, the workload imposed on the Federal Secretary is quite unreasonable. It is impossible to spread this workload indefinitely, without losing continuity, and in fact devoting more time to the instruction and co-ordination between the various persons undertaking the task. In my view, the need for a full time paid manager is no longer acute, but absolutely essential for the continued operation of our Federal body at its present level of activity.

So far as the magazine is concerned, it is not in the long term interests of our Organisation that it should be dependent on a person such as our present Editor, who is prepared to devote so many of his leisure hours to the management of the magazine, and here again he is performing a task that must be performed by one person alone. This problem has reached critical proportions, as it is no longer fair nor reasonable to expect volunteers to make such great sacrifices of their time and energies. A paid manager must inevitably result in substantial subscription increases throughout Australia. The alternative is to insist, should our Federal Organisation to the limbo of things to be done when time permits.

• CONCLUSION

In reviewing the activities of the past year, I am acutely conscious of all those many people to whom our thanks must be recorded. Because of business commitments, David Rankin has been able to devote less time to Institute activities than he would have wished. He has, however, continued to act as our Federal Activities Officer with his usual efficiency. In addition, as Federal Vice-President, I have much to thank him for, and his assistance during the year. David's experience and common sense have been of great personal assistance to me.

I have already referred to the enormous workload undertaken by the Federal Secretary, Peter Williams, and I have been in almost constant communication throughout the year. I have discovered that the work of the Federal Secretary that is seen by the public, and which is only the tip of the iceberg, Peter has devoted endless hours to the Institute, and if you agree with me, no one else has been so successful, a substantial portion of the credit for that success must lie with him. Despite an ever increasing workload, Kevin Connolly carried on as Federal Treasurer until near the end of 1969 when the post was handed over to Mr. Bill Roper. Kevin never wanted to be a Federal Secretary, but he has been the best and has kept our books in order during the past year. We are delighted to be joined by Bill Roper, who brings with him both enthusiasm and experience.

I have already acknowledged the work of David Wardlaw as Intruder Watch Co-ordinator. David, through his experience, particularly in the use of the radio, is a valuable member of the Executive, when discussing matters of an international nature, and I have valued his advice throughout the year.

During the year, Alf Seesman resigned, and was replaced by Ken Pincott, who has been the "Amateur Radio". On behalf of Executive and the Federal Council, I would like to extend our thanks to Alf for the work that he did for the Federal Executive during the years he served on it.

No more experienced or active member could be found than in Ken Pincott, and his presence on the Federal Executive in this broadest of Executive's relationship with the Institute's publications much closer.

Geo Pither has undertaken a variety of tasks during the year, and I would like to express personal thanks for his unfailing support.

In acknowledging the assistance of the various people who have contributed to our Organisation during the past year, there is one person that I cannot overlook, namely, the former Federal President, Mr. Max Hull. I have personally much valued his guidance and advice during the year, and I have felt that I have always been able to call on him for assistance, where necessary. Max has been the compilation of the Minutes of the 1969 Federal Convention, in itself a monumental task, was shared between Max and the Federal Secretary, Peter Williams.

When all seemed lost, so far as writing a history of the Institute for publication in "Amateur Radio" during 1970 was concerned, Max stepped into the breach and undertook the task. On reading the results of his research, I suspect that he did not realise the enormity of the task. Max I express my thanks of the Federal Executive, and also my personal thanks.

Finally, though again on a personal note, I would also like to express my appreciation to each member of the Federal Council for his support during the year. As I stated at the outset of this report, I believe the year past has been successful and with expectation, I believe that we may look forward to the future with some confidence, for I am sure that our Organisation will continue to grow and prosper, so long as it has the support of our members generally. This support is dependent upon those members knowing and accepting what we are doing. This has to be turned over to all the members being constantly informed on those matters that are of a Federal concern. One of the main functions of the Federal Executive is that so many matters that involve expenditure of considerable times are not either too difficult, or profitable for reporting in detail. The continued support of the Federal Councilors and through them, the Divisional Councils, is essential.

Because of the national level, our organisation is a Federation, and therefore necessarily complex, the risk of remoteness is very real. We cannot afford to be remote—we need the support of our members in Australia.

I believe we can justify that support.

Michael J. Owen,
Federal President, W.I.A.

HELP WANTED

The Publications Committee is in urgent need of extra manpower. Our present Secretary (Bill Roper) has joined Federal Executive as Treasurer, and wishes to relinquish his position with this Committee. This job entails two or three evenings per month, depending on how much work results from our monthly meetings. Although not necessary, it would be convenient if a replacement could be found who resides in one of the eastern suburbs of Melbourne.

We are also seeking somebody to assist with magazine and book reviews. Syd Clark does the job now, and it is becoming a bit too much for one man to read them all and do the review. Syd would prefer that his assistant live in the Heidelberg-Rosanna area.

Amongst the overseas magazines we receive are the journals of our kindred Societies in Italy, Spain, Belgium, France, Germany, Holland, Norway, Sweden, and South Africa. We will be happy to make these available to anybody who can read these languages if in return they will do a brief review of the contents for us.

Interested persons are asked to contact the Administrative Secretary of the Victorian Division, W.I.A. 478 Victoria Parade, East Melbourne, or phone 41-3535 and indicate in what way they can assist us. Mrs. Bellairs will pass the details on to the committee member concerned, who will in turn contact you.

Overseas Magazine Review

Compiled by Syd Clark, VK3ASC

"HAM RADIO"

November 1968—

What's this we hear about Op. Amps. by W1E0Z. The title just about describes the author's intentions. Describes Operational Amplifiers, what they do and how they are used. 17 plus pages text, photos and diagrams.

A Fixed Tuned Receiver for WWV, W6GKN. A relatively simple transistor/IC circuit for reception of WWV on your favourite frequency —15 MHz.

A Multiband Long-Wire Antenna, W1FQJ. Some 300 feet all told. No traps, some jumpers.

One More Electronic Keyer, VETBPK. ICs and other solid state components in a solid constructional article.

Antennas and Capture Area, KEMIO. Some theory you may not have seen elsewhere.

Increased Sideband Suppression for the HFT3. W3CML. None of 'em are perfect. If you own one this could be for you.

A Low Cost Amateur Microwave Antenna, K0TUL. Gain is stated to be 14 db at 3350 MHz.

A Tone Modulated Signal Generator for Two and Six Metres, W40JK. Crystal locked, too. Solid state two transistor.

Big Boom for Six Metres, W4ERO. Colinear. Repair Bench. Tuning Up SSB Transmitters. The good old.

October 1968—

Hot Carrier Diode Converter for Two Metres, K3CJU. Something new and complete instructions, too.

A Practical Discussion on Product Detector Operation, VESGPN. One for all the sidebands.

Hot Carrier Diode Noise Blanker, W4KE. HP's baby seems to be finding its way into more and more equipment. HP even have light emitting diodes at \$5 or \$6 plus tax.

Low Cost Integrated Circuit for Amateur Equipment, W4TRK. Simple new consumer ICs should appeal to the home builder who is looking for superior performance with less complexity.

Improving the F.M. Repeater Transmitter for Amateur Use, W6GDO. These simple modifications increase circuit Q and provide improved performance through lower receiver de-sensitization.

Construction of High Frequency Diversity Antennas, W2WLR. Complete details on building new designs described previously in "H.R." magazine. (There are three varieties of diversity operation: space diversity, frequency diversity and polarisation diversity—Ed.)

Solid State Exciter for 125 MHz., W1OOP. Here's a solid state exciter that converts 30 mW. of two metre drive to 32 watts on 125 MHz.

Calculated Received Power to a Radio Communications Link, W1EET. A detailed analysis of just what happens to the hard-earned watts from your transmitter.

An Automatic Two-Way DX Beacon for VHF, K4VU/K8ZDX. Simple method of ensuring that you will be there during band openings.

High Linearity Voltage Controlled Crystal Oscillator, W6BDM.

"HAM TIPS"

This month I have for review a number of letters of R.C.A. Ham Tips kindly supplied by A.W.A. Ltd.

Vol. 35, No. 3: RF "Sample Box" for "Scope Monitoring of Amateur Transmitter Output," by W1OOP.

Vol. 26 No. 4: A Solid State AM Transmitter for Two Metre Operation, W1E0Z.

Vol. 27, No. 2: A VFO Calibrator, W2YIM.

Vol. 27 No. 3: Using the MCGST as a Product Detector and AGC Gate, W3KDT.

Vol. 28 No. 1: R.C.A. Silicon Power Plastic Transistors in a Regulated DC-to-DC Converter, W1E0Z.

Vol. 28 No. 2: An Audio Control System for SSB, W2YIM.

"RADIO COMMUNICATION"

December 1968—

The Integrated Circuit Approach to AGC, GSPDM. Some very interesting ideas. Good for those with access to a transistor farm.

The GARY Two Watt Two Metre Transistor Transmitter, GEARV, G6SDH/T. Diagrams and pictures.

Technical Topics, G3VA. GSPDM high stability FET vacuum oscillator, continuously variable bandwidth filters, monitoring drive voltages, active car radio aerial. (Will the man who runs the office in the office ever again?)

Aerials and Planning Permission, G3JAC. Could help some VKs.

A Suitable for Relay Control, G3XGP.

Band Pass Filters, G3JP.

Reflections on a Bridge, G3ON. The SWR bridge is not an "island".

Changing is Metric in the U.K., E. Chicken, M.J.R.E. The differences between the Metric and Imperial systems are discussed and the Metric system is shown to have numerous advantages. This will be of interest to Australian Amateurs also because Australia is also committed to "metrication" in the long term. With the change to Metric measure will come many alterations in dimensions of various products. For instance the familiar ¼ inch tuning shaft, which is about 6.35 mm., will become 6 mm., some 5.010 inch smaller.

"RADIO ZS"

November 1968—

Portable Extending Radio Mast, Z5EET. Five sections of square section tubing 18 s.w.g. 16.94 inch which telescope one into the other. Top section is ¼ inch. The whole ends up about 24 ft. tall with two sets of nylon or similar guys. 17 s.w.g. tubing will telescope if bought in 1/8 inch sizes.

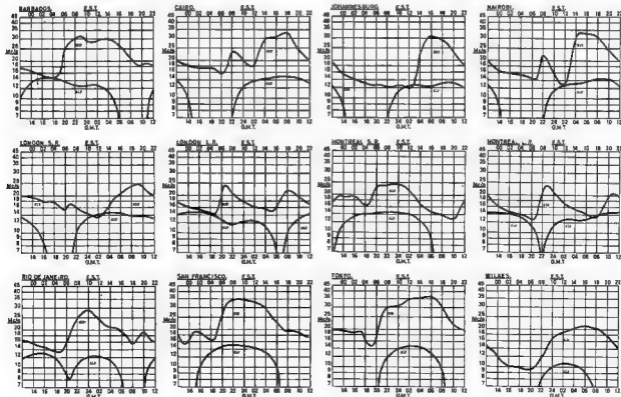
160 Metre DF Receiver, Z5SPD. To hunt that 160 metre hidden tx.

Two Valve Complete SSB Transmitter, by Z5PEX. 18AUT and 6V8 in a phasing rig for one band.

A Method of Evaluating Slide Rule Answers, Z5IMM. For the mathematically inclined.

PREDICTION CHARTS FOR APRIL 1970

(Prediction Charts by courtesy of Ionospheric Prediction Service)



Sub-Editor: ERIC JAMIESON, VK3P
Forreston, South Australia, 5233.

AMATEUR BAND DEACONS

VK4 144.300 VK4VJ, 107m, W. of Brisbane.
VK4 83.000 VK4VJ, Mount Lofly
144.800 VK4VJ Mount Lofly
VK6 83.000 VK4VF, Tuart Hill
144.800 VK4VE, Mount Barker (Albany).
144.000 VK4VF, Tuart Hill.
438.900 VK4VF on arrangement!
83.000 VK4TG, Carnarvon.
VK7 144.900 VK4VF, Devonport.
EL3 148.000 EL3VHF, Christchurch.
JA 81.900 JA1YG, Japan

As far as I can ascertain the above list is correct. If there is something wrong with this listing would you please tell me now. Sorry missed VK4VJ on 145.000 last month. Note that EL3VHF is on the same frequency, but interference seems unlikely. Anyway, you can always turn your beam to null out the offending beacon.

Southern Australia, in general, has returned to some sort of normality following the gigantic 144 MHz. opening intensity from Albany in VK8 to Melbourne and possibly further east early in February. Bernie VK4KJ must have worked over 3000 contacts in 3 metre stations, maybe I can have the number for next issue. Many operators worked Bernie over their own airway weather stations worked Bernie on 12th Feb. and these included Herb VK4KXN at Yanaq quite a long way inland. Since then there have been a number of times that the beacon VK4KJ has been heard. It is probably the best being sent on the morning of 28th Feb. by Colin VK4ZKR in Mt. Gambier, who has not yet moved.

Word has been received that the output of VK4VF is down quite a lot, but no doubt will be rectified by the time this is read. Nothing has been said in the progress on the construction of the beacon supposedly by the station in VK4, nor any move in VK8 to establish one so far.

U.F.F. RECORDS

Records are only made to be broken by others. I suppose, but they have certainly been broken lately. Firstly though, I want it to be known to all ears that the contacts by Bernie VK4KJ into Melbourne do not constitute a 144 MHz record. They certainly do for VK to VK contacts, but Hughie VK4KX still holds the overall record by working into EL3 several years ago, but VK to VK will need something akin to Bernie working someone in VK4 to cause this one to tumble, but there is hope for the future now that VK4 have their beacon running. However, back to the discussion on records.

There seems every possibility the 432 MHz. record has been broken, but only by a few miles. These records are the distance will need to be pretty sure of themselves. The contact was between Tony VK4EDY at Stirling and the VK4VJ Range near Adelaide. On Feb. 28th, VK4EDY at South Adelaide, not far from Melbourne. The distance is reputed to be 410 miles. Whether this finally settles to be the record or not, it certainly is a VK4VJ effort by these two gentlemen and with signals 1 & 8 both ways must have provided them with a bit of thrill. The outcome is awaited with interest.

The prize winning plums of course must go to the 1200 MHz. band where records have been made and broken. Ron VK4IAK at Geelong and WIZ VK4VJ at Burnie have been keeping seds for four or five months and their efforts were rewarded on 4th Feb. 100 calls for Ron and 100 for WIZ. The first when two-way contacts were made at 2000 hours EST. Reports were VK4VJ 400 and Ron 400. The distance being 222 miles, at 1745 EST they exchanged phone signals at 98. Later, the same evening about 2500, Kevin VK4ZKR worked into Ron. The distance was a VK4VJ 4 x 8. Kevin is at Nunawading, about 21 miles further north than Geelong, making a distance of 242 miles, and thus breaking the record of a few hours' duration from Ron. Such is the luck of the game of course, but congratulations are due all round, and Ron and Kevin are to be congratulated for their efforts a record was finally established on the

band, in essence of that earlier made in VK4. Following are a few brief details of equipment used, kindly supplied by Peter VK4ZYO.

VK4VJ Varactor type MA4909 tripler from 144 to 432 MHz. followed by 300 ohm valve tripler to 1200 MHz using the R.S.G.B. strip line design. The 1 metre exciter is an s.b. job with carrier resonated. The R line up to a crystal detector to a 100 ohm resistor on 25 MHz into a Yessu Mullen FR400 re.

VK4IAK Radial cavity tripler XCBMA, running 3 watts output, with both the 432 MHz. tripler and the 1200 MHz. tripler. A 100 ohm isolated seven foot dish with slot feed dipole about 4 feet high. INZER diode mixer to 144 MHz.

VK4ZKR Solid state equipment to 144 MHz. The MA4008 varactor to 432, giving about 30 watts, then into a u.h.f. transformer base-collector junction. Moyle varactor to about 1400 MHz. output Receiver uses C80 vacuum diode, 70 MHz. first i.f., 2.4 MHz. and i.f. Four-foot dish about 30 ft. high.

Another long haul contact on 432 MHz. was between Herb VK4KXN at Birchup and WIZ VK4VJ on 4th Feb. This was at first reported in various on-air conversations as being a new record, but checked and revealed that it was not so, the distance being about 370 miles. Quite a good contact, however, and the participants were both very happy.

Bob VK4IAOT sends a very newsworthy letter, and some excerpts are quite interesting. His canyon trip to Mt. Runyon during Jan. method of 432 contacts for eight or ten days. He was 82, 144 and 432 MHz. Finally with the joy of that period, he went out to Mt. Buffalo for a week-end. A last-minute change of cars meant he could only take low power equipment with him, due to weight problems. There was not a lot of problems. First a boiling radiator, simultaneously a front tyre blow out. These fixed, Bob was blinded by the sun going up the mountain and crashed into a ditch, damaging the car, but worse still, wrecking his 25 element 432 MHz. coilformer. Finally, they made it, 15 miles after leaving Melbourne, for a distance of 150 miles. He called back heads off for 15 contacts only, leaving for home at 1540 on the Sunday. More car trouble forced him to turn back at 1540 on the Sunday. Then a puncture. Jack went to work, damaged in crash. Finally got to within 15 miles of home, but then a car problem. This time he got to garage home at 6:00. All this could be just about enough to kill anyone's enthusiasm, but Bob indicates he expects to go to Mt. Buffalo over the weekend, and then to 1200 MHz. gear. Best contacts from Mt. Buffalo were to AXIAK/A, the Canberra Radio Club, Mt. Glinski, and VK4ZKR to the Canberra Radio Club, and VK4ZKR to the Canberra Radio Club. Bob reports VK4IAK worked Ron VK4IAK at Geelong and Geoff VK4IAK at Frankston, and a couple of others for distances of some 200 miles. He mentions that on the Sunday morning of the N.F.D., Lance VK4ZKR worked AXIAK/WJ on Mt. Blue, a distance of about 48 miles. A good effort.

Interested to note a comment in the VK8 V.h.f. Group News Bulletin that the John Moyle N.F.D. created virtually no v.h.f. interest in that State, principally because of the low scoring for v.h.f. contacts unless 53 MHz. opened to the eastern States. General opinion indicated that at that point, the N.F.D. was limited to the h.f. bands.

The contribution from VK8 for this year's N.F.D. would not be very great I am thinking. While it is true that the weather is not ideal, weather conditions and excellent v.h.f. conditions, producing contacts over many hundreds of miles, and some of them are very good. At the least. On the Saturday century best conditions prevailed, culminating in the hottest day on the Sunday for 15 months, with the heat wave during the day. I was out on 400 John VK4ZKR and myself went out on to Mt. Gawler, some 15 miles north-east of Adelaide. The field day. All the equipment was in a caravan and we were operational on all bands from 160 metres to 432 MHz. Due to the hot weather, v.h.f. contacts just did not exist to show contacts other than local. We ran up the poorest score for years on these bands. I am sorry to have to admit it, but I think it is not because of the equipment, but with us, we would have twiddled our thumbs for most of the period. We finally packed it up on the Sunday after sweating in the car, van for hours, before 0900 it was above 90 degrees, reaching 112 degrees at 1630. When the heatbaths on the transferred equipment just almost red hot around 1600 degrees. Undaunted, however, we will try again next year.

Ross AXARO writes indicating quite a lot of interest by himself and the Townsville Amateur Radio Club in the suggested message handling of a few months ago. It appears the problem has been solved. The problem of after the gap which exists in that State by

running a station at Bowen to get the message to Townsville and then on to Cairns. There is still one gap around Mackay which needs to be filled. I am looking for some help in this area and will be pleased to hear from anyone able to operate some 2 metre equipment in that area. Having achieved this, then I think the message can get under way. There then seems to be a very little reason why a signal cannot travel from VK4 at least to northern VK4 and back again in a short period of time. I am sure a signal from space. But matter of trying to bring the VK4s into it. More details as soon as possible.

AUSTRALS OSCAR 5

The 144 MHz beacon on Oscar 5 has finally gone into silence after operating so efficiently for several weeks, and giving more Amateurs the thrill of hearing a signal from space. But any former orbiting package has done. The signal was so strong on occasions that with even rapid turning of the hand would make anyone stop and listen. The depth of modulation on the beacon was excellent and it is a great pity the 29.50 MHz. beacon is not working so well. All in all, however, a triumph of engineering for all concerned in the Project, and I feel sure I speak for the Amateur fraternity when I say that the project was a great success. I am sure a full report of the performance will be made in the next issue of the pen of those more intimately concerned.

DX on 8 metre has now subsided except for an occasional sporadic but this has certainly been a very good job. Over the weekend VK4ZKR in Mt. Gambier writes that the boys down there have been right amongst the DX. It is already on and now Chris VK4ZFA is operating VK8 2, 3, 6 & 7, while Ray VK4KXN went one better and worked VK4J during the N.F.D. week-end. It is interesting to know that the southern States will be interested in quite an upsurge in 432 MHz. activity is likely soon from Mt. Gambier. Colin VK4ZKR is already on and now Chris VK4ZFA is operating on s.b. with a QQQQ/40 mixer. Col VK4ZK and David VK4ZKO are both building conveyors. Eric VK4KXN at Hamilton showing quite a lot of interest. For antennas, the 53 element extended array is currently coming in for a lot of praise by a number who are using it. Colin says the path between Tony VK4EDY at Stirling and himself seems to have shortened since erecting one himself, signals being considerably improved. I am sure the 53 element phased array. Anyway, there may be no one left on v.h.f. in Mt. Gambier soon when we hear all the Z call chaps down there are sweating home and hoping to sit for the c.w. examination later this year.

I guess that will have to do for this month. Before closing, let me think of the thought for a month. "It is not true that women want a great deal. A woman is quite content with very little, if that very little is precisely what she wants it not, then nothing is enough." Hope everyone has a real "ball" with DX over the Easter week-end.

73, Eric VK4KX, The Voice in the Hills

MEET THE OTHER MAN

Meet Eddie Penkiss, 8/1 Northbourne Flats, Canberra City, VK4VJ, formerly VK4VJ and VK4VJ. Eddie has been known to have worked 6 metre operators for years and has certainly done much to keep Canberra on the radio map, so much so that he is a life member of the Canberra Radio Society. First licensed in 1932, Eddie operates on 53, 144, 432 and 1200 MHz. and is certainly a man of many operating modes. His home station's details are as follows, briefly: 53, on c.w./a.m./s.b./f.m., running 100 watts to QQQQ/60, with a c.w. signal 100 feet high. Translated converter with 82000 in front end. On this band,

(Continued on Page 24)

Eddie Penkiss, VK4VJ

Correspondence

Any opinion expressed under this heading is the individual opinion of the writer and does not necessarily coincide with that of the Publishers.

INTERFERENCE FROM RADAR-TYPE PULSES

Editor "A.R.," Dear Sir,

For some time past radar type pulses have been heard on the air and more recently but loudly across the h.f. spectrum. At times the pulses exceed 50 and on the 15 and 20 metre bands are often heard simultaneously in Australia and Europe. The format of these "clicks" is a short train of sharp pulses apparently of high power, repeated at short intervals and followed by clearly recognisable echoes.

On occasions the resultant composite interference is so persistent and strong that even s.b. voice communication is interrupted. Narrow band communications are not so seriously affected.)

On the night of 12th February when this noise was particularly persistent, I tape recorded a 15-minute sample showing how the pulses affected Amateur operation on the 15 metre band. This has been passed to the District Radio Inspector together with a formal request that something be done to minimise this type of emission.

The "signal" apparently originates in the Central Pacific and is said to be part of an exotic (American) ionospheric prediction system, which although attracting unfavourable comment from several sources, seems destined to continue unless the level of protest rises considerably.

Would members who are concerned about the selfish type of use of the h.f. spectrum in Region 1 please lodge an appropriate protest with either their local R.I. their W.I.A. Council and/or the A.R.R.L.?

—Col Harvey, VK1AU.

[Better still, refer it to your Intruder Watch Co-ordinator.—Ed.]

AUSTRALIA—AND CAPTAIN COOK

Editor "A.R.," Dear Sir,

I refer to VK1JG's opinion expressed on page 28 of "A.R." Mar. 1970, in which he makes an awful "boob" in my opinion, by saying that he has "nonsense on the air" in relation to the Australian call signs, and then offers his version of what the "so-called" nonsense should become.

I refer Mr. George to the Radio Regulations, Geneva 1968, page 324, Regulation 17.21(d), which, in relation to call signs, reads as follows:

"Amateur and experimental stations—one or two letters and a single digit (other than 0 or 1), followed by a group of not more than three letters".

and

"73 2. However, the prohibition of the use of the digits 0 and 1 does not apply to amateur stations".

To the writer and, I hope, to all average, clear thinking readers, the aforesaid regulations clearly set out the Amateur Radio call sign position.

Insofar as VK1JG is concerned, I feel it's a case of the boot being on the other foot, with "..." this nonsense on the air" being said by Mr. George if he introduced the word "Australia" into preceding his call sign.

—Eric Trebilcock, AX-L2042.

"SIX AND IRON"

Editor "A.R.," Dear Sir,

I wish to offer my sincere congratulations to those responsible in the Wireless Institute of Australia for the inauguration of the Cook Bicentenary Award. In line with other segments of our Australian community, we cer-

tainly have something to celebrate and I think the majority of Amateurs will support the W.I.A. in a magnificent effort to create greater interest in our young country by communication with Radio Amateurs throughout the world.

Monitoring the 20 metre band since the beginning of January this year, I have noticed a welcome increase in c.w. and s.b. activity and from comments on the air it would appear that the AX Award has contributed to a large degree to this increased activity.

However, as the English mathematician, Sir Isaac Newton, stated in 1706, "To every action there is an equal and opposite reaction", I now refer to an international incident mentioned recently on the 20 metre band.

Scene 1: American Amateur. "Say Old, you are using the VK prefix, how about the AX prefix to give me another contact?"

Australian Amateur. "Sorry OM, I don't alter my call sign for anybody".

Scene 2: American Amateur in a long QSO with a VK3 over the long path. American asks for an AX prefix. Australian Amateur disagrees.

Scene 3: A VK3 character, well known for his sales ability, stated on the 40 metre band: "Captain Cook did not discover the East coast of Australia and I will not use the AX prefix."

Scene 4: I have listened to the VK3 characters who work a daily net on 7.1 MHz., particularly at 8 a.m. after they have had a bad night and try to get an AX prefix out of them.

I conclude by suggesting that there are a number in our ranks who should sit and think, and having sat in contemplation, thank the good Lord that they are part of a young country built on a heritage of courage and endeavour.

I await their reply.

—Wai Y. Salmon, VK3SA.

RADIO TELETYPE INTERFERENCE

Editor "A.R.," Dear Sir,

From conversation with other Amateurs it appears to me that a lot of r.t.t.y. Amateur-band interference is blamed on Amateurs. Those who may be interested in the encroachment on the Amateur bands should note that, in my experience anyhow, Amateur r.t.t.y. operators transmit just outside the phone bands in the c.w. section only over a narrow section at that.

It is a very simple matter to determine if the r.t.t.y. operator is an Amateur as QSOs are of the same form as phone QSOs, of comparatively short duration, and also the Amateur finishes each over with his call sign in c.w.

So be happy in the knowledge that the r.t.t.y. QRM spoiling the bands, 20 metres especially, is not caused by your fellow Amateurs.

—Peter H. Brown, VK4PJ.

OBITUARY

VINCENT JEFFS, VK4VJ

The VK4 Division recently suffered a severe loss in the passing, aged 58 years, of Vince Jeffs, VK4VJ, an extremely popular member, who was comparatively recently elected a Life Member for his services in the Division.

Vince, who passed away while in hospital, had some two years ago retired from business because of ill health and, while in hospital on that occasion had the misfortune to lose his wife.

To sea and married daughter, VK4 members extend their sympathy.

Vince, licensed in 1931, was one of the earliest experimenters on a.s.b. and in the use of transmitters. He willingly passed on his knowledge.

His interest in field days, Scouting, conventions, etc., was evinced by his full participation, while he operated VK4VJ for a time and as a capable telegraphist he handled Morse sessions.

Vince, well spoken and with a fine sense of humour, will be missed for many days.

CONTEST CALENDAR

Until 19th April: I.A.R.C. Propagation Research Contest (Phone)

11th/12th April: "CQ" WW WPX S.b Contest

19th/16th August: Remembrance Day Contest.

3rd/4th October: VK/ZL/Oceania DX Contest. Phone Section

10th/11th October: VK/ZL/Oceania DX Contest. C.w. Section.

10th/11th October: R.S.G.B. 25 MHz. Phone Contest.

24th/25th October: R.S.G.B. 7 MHz. DX Contest (C.w.).

7th/8th November: R.S.G.B. 7 MHz. DX Contest (Phone).

5th Dec., 1970, to 11th Jan., 1971: Ross A. Hull V.H.F. Memorial Contest.



TO SAFETY

WIRELESS INSTITUTE OF AUSTRALIA FEDERAL EXECUTIVE

The Institute can now offer annual subscriptions to following Amateur Journals:

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CHANGE OF ADDRESS

W.I.A. members are requested to promptly notify any change of address to their Divisional Secretary —not direct to "Amateur Radio".

FEDERAL AWARDS

COOK BI-CENTENARY AWARD

The following additional stations have qualified for the Award

Cert No.	Call	Cert No.	Call
41	KG4AL	73	AZ4XJ
42	AX2EF	74	ZB3AAA
43	AX8RO	75	ZB3FC
44	AX3HL	76	W5QZK
45	AX7KW	77	ZM1GW
46	AX3ZE	78	VQ8CR
47	UB8WE	79	KA4BA
48	XW1CS	80	AX4DV
49	AX6WT	81	OH2BAO
50	AX8DS	82	V56AM
51	KA6MF	83	KP4CL
52	UA8RE	84	ZM3BGV
53	HR1WSG	85	KG4AS
54	CP1GN	86	NR1EAS
55	LA8T	87	AX8EP
56	ZM8GJ	88	KR1BU
57	Z55PG	89	GJ3XN
58	ZL1AMN	90	ZM3LJ
59	AX2EK	91	AX8RU
60	AX7VX	92	W8RU
61	AX4VX	93	W1AA
62	W4ATO	94	XG3KU
63	AX7DK	95	DL1NEA
64	AX2XT	96	HS1AA
65	AX4VY	97	W4SSNM
66	AX2KA	98	AX3AO
67	ZM3HN	99	AX3CK
68	AX2QO	100	Z13VY
69	KP4BT	101	ZL4NH
70	GP1PI	102	AX3EF
71	AX3PT	103	DJ3DA
72	JH1EXV	104	

VK3 S.W.L. GROUP

REGISTERED S.W.L. NUMBERS

Due to the fact that the Short Wave Listener Group have been without a Secretary for some time records have got into arrears. We are happy to announce that the position has now been filled and we want to rectify any anomalies that could exist.

Would all members who have applied for an S.W.L. number and have not as yet received it, please communicate direct with the Secretary, who will then answer by return mail.

Please contact:

Mr. E. Milton,
11 King William Street,
Reservoir, Vic., 3073; or Phone 47-1376.

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CAPTAIN COOK BI-CENTENARY CELEBRATIONS, 1970

Expedition to Cape Hicks

During April 1970 representatives of the Victorian Division of the Wireless Institute of Australia will be operating an Amateur Radio Station at Cape Hicks, the first point of the Australian coastline sighted by Captain Cook in 1770. The Amateur Radio Station, using the call sign AX3AWI/Portable, will contact Australian and overseas Amateur Stations during the three-day period of operation.

DETAILS

Date: 18th, 19th and 20th April, 1970.

Call Sign: AX3AWI/Portable.

Location: Cape Hicks, Victoria, Australia.

Bands: 15, 20, 40, 80 and 160 metres, also v.h.f.

Times: 0200 GMT 18/4/70 to 0200 GMT 20/4/70.

QSL and Awards—A special certificate and QSL card will be issued—applications via VK QSL Bureau, or direct to address below.

Further information can be obtained by contacting Russell Kelly, AX3AG, Divisional Secretary, W.I.A. Vic. Div., P.O. Box 36, East Melbourne, Vic., 3002.

W.I.A. D.X.C.C.

Listed below are the highest twelve members in each section. Position in the list is determined by the first number shown. The first number represents the participant's total countries less any credits given for deleted countries. The second number shown represents the total D.X.C.C. credits given, including deleted countries. Where totals are the same, listings will be alphabetical by call sign.

Credits for new members and those whose totals have been amended are also shown.

RECEIVER			
VK3MS	316/340	VK5AB	297/314
VK6RU	312/338	VK4KS	288/304
VK4RO	311/338	VK4PJ	285/305
VK4AR	309/332	VK4CT	284/283
VK3JZ	307/325	VK3APK	271/283
VK3MK	303/322	VK3TL	271/277

New Members:			
Cert. No.	Call	Total	
105	VK3WY	102/103	
106	VK3AKZ	103/105	
107	VK3EP	90/100	

Transmitters			
VK3EZ	247/244	VK3TG	164/158
VK3AKM	211/211	VK4RP	160/160
VK3BR	150/153		

G.W.			
VK3AHQ	301/215	VK3VL	272/228
VK3GL	300/223	VK3DB	270/287
VK4PF	280/215	VK3AR	269/278
VK4ER	267/209	VK3RU	266/289
VK3AGH	282/286	VK3NC	263/285
VK3APK	274/228	VK4TY	259/272

Amateurism:			
VK4RP	146/156		

OPEN			
VK6RU	314/330	VK6MK	304/284
VK3BR	312/333	VK3ZD	303/281
VK3AGH	310/323	VK4PJ	297/282
VK3VY	308/323	VK3APK	294/295
VK3GD	304/221	VK3AR	292/291
VK4TY	300/281	VK4ES	290/288

New Member:			
Cert. No.	Call	Total	
132	VK3EF	101/100	

SILENT KEYS

It is with deep regret that we record the passing of—

VK3KX—Ronald Tandy

L-3324—Jeff Van Loon

VK4VJ—Vincent Jeffs

HAMADS

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FOR SALE A.W.A. AMT150 Transmitter including power supply and spares in excellent condition and complete with original transistor case \$40. Also SC147 Base w. including transformer and aerial 1.3-30 MHz., in good working order, \$40. Contact B. den Hertog, 41 Arcadé Road, Glebe Point, N.S.W., 2037.

FOR SALE FS20 Receiver, six Ham bands only plus WWV, perfect order with 12v. transistor supply, \$150 o.n.o. One Palac Valve Tester with built in Multimeter. \$15. One 5 W R Meter, 75 ohms, \$15. Set of 5 meter, and course incomplete. Photo graphs available \$70 o.n.o. W1A-1377 T. Hamling, 88 Heywood Rd., Williamstown, Vic., 3015. Phone 389 5773 (Melb.).

FOR SALE Galaxy 3 S.B. Transceiver, complete with matching power supply and speaker crystal calibrator and vox \$325, Phone 36-0845 (Melb.).

FOR SALE Galaxy 3 Transceiver, perfect condition, with m.s. vox, a.t.u. power supply, handbook. \$400. Phone Melb. 62-7105, VK3ZZZ, 4/2 Auburn Gr. Hawthorn, Vic.

FOR SALE General Coverage Communications R-400 front and double conversion 18 valves, RFO and det. 5 meter, and course incomplete. Photo graphs available \$70 o.n.o. W1A-1377 T. Hamling, 88 Heywood Rd., Williamstown, Vic., 3015. Phone 389 5773 (Melb.).

FOR SALE Hallcrafters SX101, Mk. 2, Ham-band Rx, 160-10 MHz. Switched 88, xtal cal, 0.5 kHz., c.w. sel. Excellent performer VK4FD, C. B. Stegling, 35 Moncrieff St., Sandridge Hill, 4070.

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		2 element		

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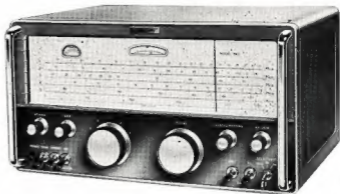
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- ★ Multi-scale panel meter, fully calibrated, provides direct reading of PA current, plus relative power output, ALC indication, Rx, "S" units.
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